POWER

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The Salesmen's Reply

By William A. Dunkley

An answer to "The Troubles of the Manager," in the March 30 issue.

We get our hot times here on Earth, then climb the "golden stair."

THE MANAGER'S a grouchy cuss, although he has it soft
And lounges in an easy chair and wears out good broadcloth
He has his car, he has his golf; these joys cannot allay
The grouch that grips his vitals when we boys come his way.
Outside his door an office boy confronts us with a frown
And says, "Come back some other time, the 'Old Man's out of town'
And if at last we pass the door and beard him in his lair,
He acts as though "Old Nick" himself would be more welcome there.

He sits and smokes our good cheroots (We buy them three for five),
And he is game to buy our goods in case he can survive.
We show him how to save his dough and how to spend it too.
He may have tried some other line, but ours is "something new."
We're agents of prosperity and keep him up to date,
And any plant without our goods would meet a sorry fate.

But when he gets to Satan's realm, he'll find no salesmen there.

Some time ago we met a chap who ran a power plant,
And every day he'd tear his hair, and cuss, and rave, and rant.
Directors had him going right, the dividends were slim,
And costs were soaring out of sight; looked like "good night" for him.
His durned old plant was out of date, and leaks were everywhere,
And here a groan and there a knock, were crying for repair.
He wasn't wise to boiler scale, much less to CO_2
And half his good bituminous was wasting up the flue.

We talked to him until our throats were parched as desert sand;
But "soda water" fixed us up (guess you will understand).
And finally, he was convinced and purchased half our line;
And now, that same old power plant is running something fine.

We are the manager's best friends, we help him to progress,
And steer him up the narrow path to honor and success.
And when at last he shuffles off, beyond the milky way.
We have a line of golden harps to make his future gay.
And if instead, he goes below in spite his good intent,
We'll lag him well with fireproof paint, asbestos and cement.
But when he gets to Satan's realm, he'll find no salesmen there;
We get our hot times here on Earth, then climb the "golden stair."

Power Plant of the Hughes Electric Co.

By C. P. Larsen

SYNOPSIS—This power plant supplies electrical energy for motor and lighting service and for operating the pumping plant. Exhaust steam is used for district steam heating. Lignite containing 6590 B.t.u. per lb. is used as a fuel. Burning 42 lb. of coal per square foot of grate area, 3 lb. of water is evaporated per square foot of boiler heating surface.

The power house of the Hughes Electric Co. supplies the town of Bismarck, N. D., with light, heat and power and also pumps the water for the Bismarck Water Supply Co. The boiler room, Fig. 1, contains four water-tube boilers, each rated at 306 hp., having 3060 sq.ft. of heating surface, and two return-tubular boilers, each rated at 150 hp. The boilers are hand-fired, as no stokers are known for burning lignite that will give as good results as are obtained with hand firing. Each furnace of the large boilers is equipped with 48 sq.ft. of grate surface, or one to each 63.75 sq.ft. of heating surface. The grates used are of the flat sawdust type, perforated with half-inch holes, which give about 20 per cent. air space. This does not conform with modern practice for burning low-grade fuel, as with an increased grate surface a boiler can be forced to a greater extent, but it is a question if the combustion will be so complete with a lignite fuel that is low in carbon and contains so much volatile matter that must be taken care of to obtain efficiency. With this ratio of grate to heating surface, 3 lb. of water is evaporated per square foot of heating surface and 42 lb. of coal is burned per square foot of grate surface.

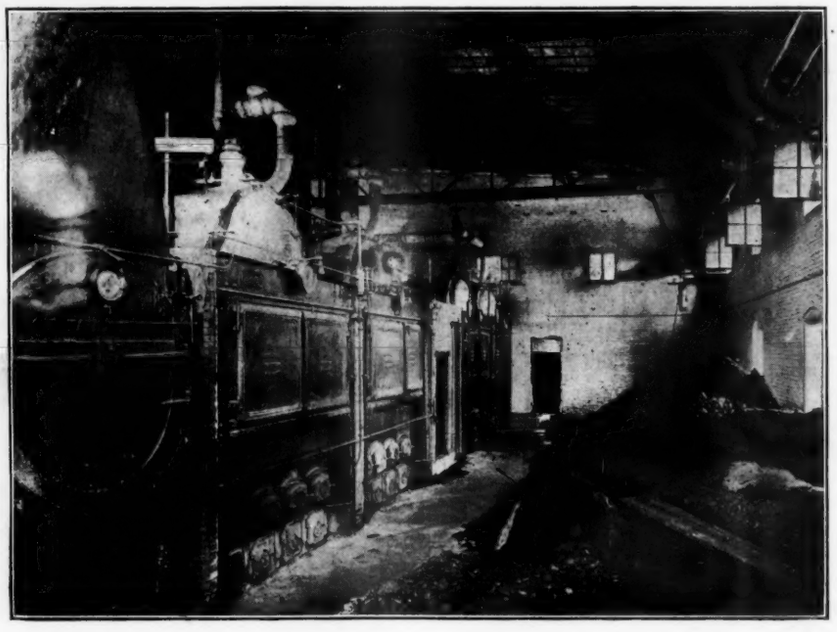


Fig. 1. Boiler Room of the Hughes Electric Co.'s Power Plant

Lignite burns much like dead wood or brown paper, with a natural slow draft, and it can burn like a blacksmith's fire and give off very little heat. It will slack and turn into dust, and when fired under a boiler in this condition the design of grate is of importance, as with a 40 per cent. air space there is little chance for the fuel to rest while it burns, for it is in continual motion, rolling around and mixing with ashes, which results in a flameless fire. If the air pressure under the grates is increased, holes will be blown in the fuel bed through which air will pass freely and cool the furnace.

It is necessary to level off the bed of fire or fill the holes with a fresh supply of coal, but if the fire is in bad shape there is no remedy, and the only thing to do is to pull it and start a new one. With less air space the fuel has a chance to rest on the bridges between the holes and each hole will form a little burning jet, as a higher air pressure can be maintained under the grate. The greater the velocity of the air through the holes, the greater the increase in the temperature; about 1900 deg. is obtained and a flue-gas temperature of about 450 deg. F., with an average of 12 per cent. CO_2.

There is a peculiarity in burning lignite coal as it can be easily wasted owing to the amount of air required for combustion. The long flame, with its low temperature, carries the unignited gases through the boilers and up the smoke-stack and produces a deceiving temperature of flue gases. It is possible to burn 60 lb. of coal per square foot of grate surface and evaporate but 3 lb. of water per square foot of heating surface and have a flue-gas temperature of but 350 deg. F. Then again, it is possible to change the air supply, break the coal to suitable sizes, burn 35 lb. of coal per square foot of grate surface, evaporate the same amount of water per square foot of heating surface and have a flue-gas temperature of 450 deg. F., a decrease in fuel consumption of 41 per cent.

An average evaporation of 4.5 lb. for a month's run is obtained in many tests, and during short tests as high as 4.85 lb. of water per pound of coal has been evaporated; the temperature of the feed water being 190 deg. F., steam pressure 140 lb. and the coal containing 6590 B.t.u. This is equal to an evaporation of 8.8 lb. of water from and at 212 deg. F. per pound of combustible and shows an efficiency of about 77 per cent. These results are obtained by using forced draft with a slow velocity, so that the heat in passing through the boiler is absorbed by the water. It is not advisable to force a boiler above its normal rat-

ing. It is easy to force the fires and send a flame out at the top of a 50-ft. stack, but at the same time the boiler is not generating steam in proportion to the fuel burnt.

It is not an easy matter to lay down a general rule for burning lignite. The coal burned at this plant is a low-grade fuel containing about 6500 B.t.u., between 35 and 40 per cent. moisture and from 5 to 10 per cent. ash. It is not suitable for long shipments or storage in warm weather, as it slacks, or pulverizes, like burnt lime when it loses its moisture.

It is delivered to the power house in railway cars and unloaded into a bucket conveyor about 150 ft. long, extending 60 ft. outside of the building alongside the railroad track. Two cars can be unloaded at the same time. In the overhead run the conveyor is provided with chutes for each boiler. Its capacity is 25 tons per hour and it is driven by a 10-hp. motor. The cars on the side track are moved by a car puller driven by a 5-hp. motor.

The cost of handling the coal from the cars into the boiler room is 9c. per ton. The plant is 25 miles from the mine and the coal, which runs in size from 6-in and down to dust, costs $1.75 per ton delivered at the plant. Once in a while a car of slack is received, at $1.15 per ton, which helps to bring the average price of the fuel down.

The boiler room is 60x80 ft. and 30 ft. high. There are three steam-driven boiler-feed pumps, two vacuum pumps, one air compressor, one boiler-washing pump and one open feed-water heater. The last is merely a tank, and as the condensation from the heating system has at times a temperature of 165 deg. F., it is found to be more economical to turn the exhaust from the vacuum and boiler-feed pump into the heating system when live steam is required. Otherwise, it heats the feed water up to about 200 deg. F.

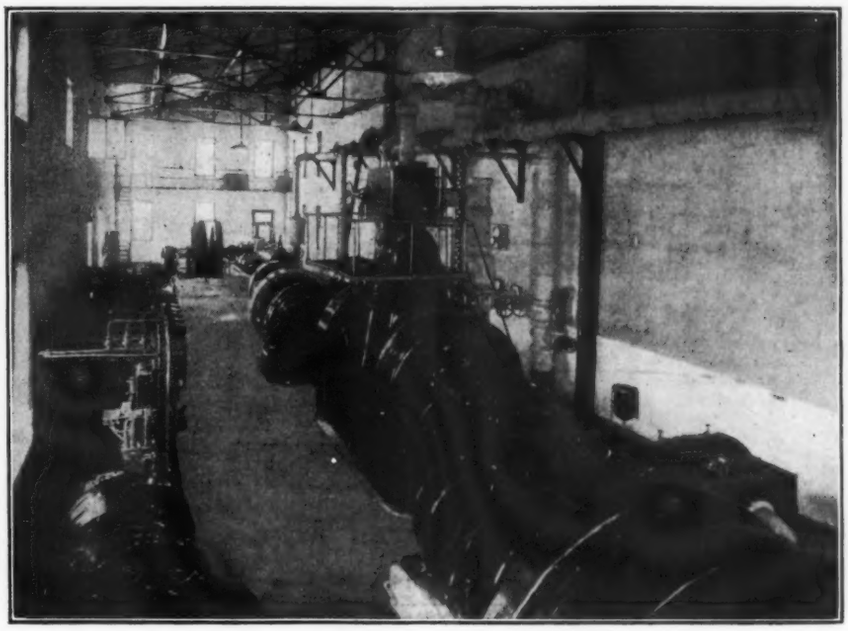


FIG. 2. GENERAL VIEW OF THE ENGINE ROOM

A 30-in. fan for forced draft is driven by a 15-hp. motor. The air for this fan is taken from above the boilers and as it passes through the combustion chamber to the ashpit, it is warmed to some extent. The main boiler-feed pump has an 8-in. suction pipe and a 6-in. discharge, with 2.5-in. feed line to each boiler. The regulating valves are conveniently located; the steam pipe from the boilers to the 12-in. header is 6-in., equipped with automatic stop valves. All pipes, fittings and valves are extra heavy.

The engine room, Fig. 2, is 30x115 ft. and 25 ft. high; it is neatly finished, and contains only the generating units, exciter and switchboard. It has a terrazza floor with marble borders, and the side walls are wainscoted 5 ft. high with white enamel-brick; the engine beds above the floor line are painted silver gray; across one end of the room is a balcony, where the chief engineer has his desk. A winding iron stairway leads to this balcony.

The engine room contains five units. The smallest is a 12x12-in. engine running 270 r.p.m., with a steam consumption of 28 lb. per i.hp.-hr., and is directly connected to a 75-kw., 230-volt, direct-current generator. Unit No. 2 is a 16x16-in. engine running 270 r.p.m., with a steam consumption of 28 lb. per i.hp.-hr., and is directly connected to a 100-kw., 230-volt, direct-current generator. Unit No. 3 is a 20x18-in. vertical engine running 200 r.p.m., with a steam consumption of 35 lb. per i.hp.-hr. and is directly connected to a 200-kw., alternating-current, 60-cycle, 2300-volt generator. Unit No. 4 is a 14¼&25x18-in. cross-compound engine running 200 r.p.m., and uses 22 lb. of steam per i.hp.-hr.; it is directly connected to a 250-kw., 60-cycle, 2300-volt alternating-current generator. This unit has its exciter on the main shaft. Unit No. 5, Fig. 3, recently installed, is a 23x30-in. engine running at 150 r.p.m., and uses 23 lb. of steam per i.hp.-hr.; it is directly connected to a 500-kw., 60-cycle, 2300-volt, alternating-current generator. This generator is excited by a 35-kw., 125-volt, direct-current generator driven by a 50-hp. induction motor. Switches are arranged so that either unit can be excited from the 35-kw. exciter. A motor-driven exciter is used for No. 3 unit, as the company furnishes either direct or alternating current to its customers. There is also a 100-kw. motor-generator set, and as this is usually generating direct current the power factor in the alternators is increased by having this synchronous motor in the circuit. The switchboard has fourteen marble panels and is equipped with voltage regulator for the alternating-current circuit, circuit-breakers, switches for the generators and transmission lines, voltmeters, ammeters and wattmeters, and synchronizing indicator. In the engine room is a 30-kw. constant-current transformer for city arc lights.

The plant has equipment sufficient to supply an ordinary city of 20,000 inhabitants with electricity. Bismarck has a population of 7000 and about thirteen years ago the company started an electric plant with a 50-kw. unit. The rapid growth of the city, however, has constantly made demand for more units. The rate charged for cooking service is 3.5c. per kw.-hr., for lighting service it is 10c. to 12.5c., and for power service the rate is according to the amount used, from 1.5c. up.

The company is operating the city pumping station lo-

cated on the banks of the Missouri River. The water flows by gravity into a receiving well 12 ft. in diameter. From there the water is pumped to three reservoirs on a hill 200 ft. above the river. Each reservoir holds about one million gallons. A 13x16-in. triple-plunger pump, belt-driven by a 100-hp. induction motor was recently installed. The speed of the motor is 450 r.p.m. with a 26-in. diameter pulley; it is belted to a countershaft with a 70-in. diameter pulley, 22-in. face. A 20-in. double-ply leather belt is used, and the crankshaft is speeded down to 34 r.p.m. by cut gears. The plungers have a displacement of 935 gal. per min. and the water pumped is 926.5 gal. per min. This allows 8.5 gal. for slippage, or 0.9 per cent.; 46 kw. are recorded by the wattmeter at this load, and as the theoretical kilowatt consumption for lifting 926.5 gal. to an elevation of 200 ft. is 34.8, this gives a combined efficiency of 75.7 per cent. for the motor and pump.

There is pumped 1208 gal. per kw.-hr. to an elevation of 200 ft., 13 ft. of this being suction lift. As the Nos. 4 and 5 units give the best steam efficiency, these are operated the most. With either, 8 lb. of lignite coal is burned per kilowatt generated and put into circuit; this includes steam for operating the boiler-feed pump and the vacuum pump for the heating system; also current for operating the forced-draft system, for the motor and for the station lighting. In summing up the combined efficiency of these units and the pump, it shows that one pound of this low-grade lignite coal is elevating 151 gal., or 1258 lb., of water 200 ft.

A central heating system is also operated. The exhaust pipes from the engines are connected to a 16-in. exhaust header, which has a 12-in. outlet to the atmosphere, a 6-in. connection to the feed-water heater, and a 12-in. main to the heating system. The condensation is returned to the heater by vacuum pumps. Central heating has proved so satisfactory that the demand for steam has increased more rapidly than the electrical output, and to such an extent that in cold weather about 60 per cent. of the total steam generated in the boilers passes through a reducing valve to the heating system. The rate for steam is 40c. per 1000 lb. All customers are charged on a meter basis.

Condensation from the mains and branches is trapped off where the pipe enters the customer's building. These bleeders trap off about 20 per cent. of the steam output from the boiler. In the 16-in. header is a 16-in. oil and steam separator, from which the condensation trapped off amounts to 12 per cent. The condensation from the high-pressure pipe line and receiver, steam separators and exhaust from the boiler-feed pumps, enters the open feed-water heater and amounts to about 4 per cent. The total of those items amounts to 36 per cent. of steam generated but not passing through meters. Those losses are not constant, as the percentage lost is less in cold weather with a greater steam consumption, though owing to these condensations the company receives only 27c. per 1000 lb. of steam generated; still, the output of steam for the month of December, 1914, made a favorable showing, as 9,844,000 lb. was recorded by the meters in the heating system and 3,444,400 lb. of coal was burnt during the month, at a cost of $2686.32, or $1.56 per ton. As during the winter months there are many sunshiny days with a comfortable temperature, considerable exhaust steam escapes to atmosphere during peak loads. This is a natural loss and cannot be controlled.

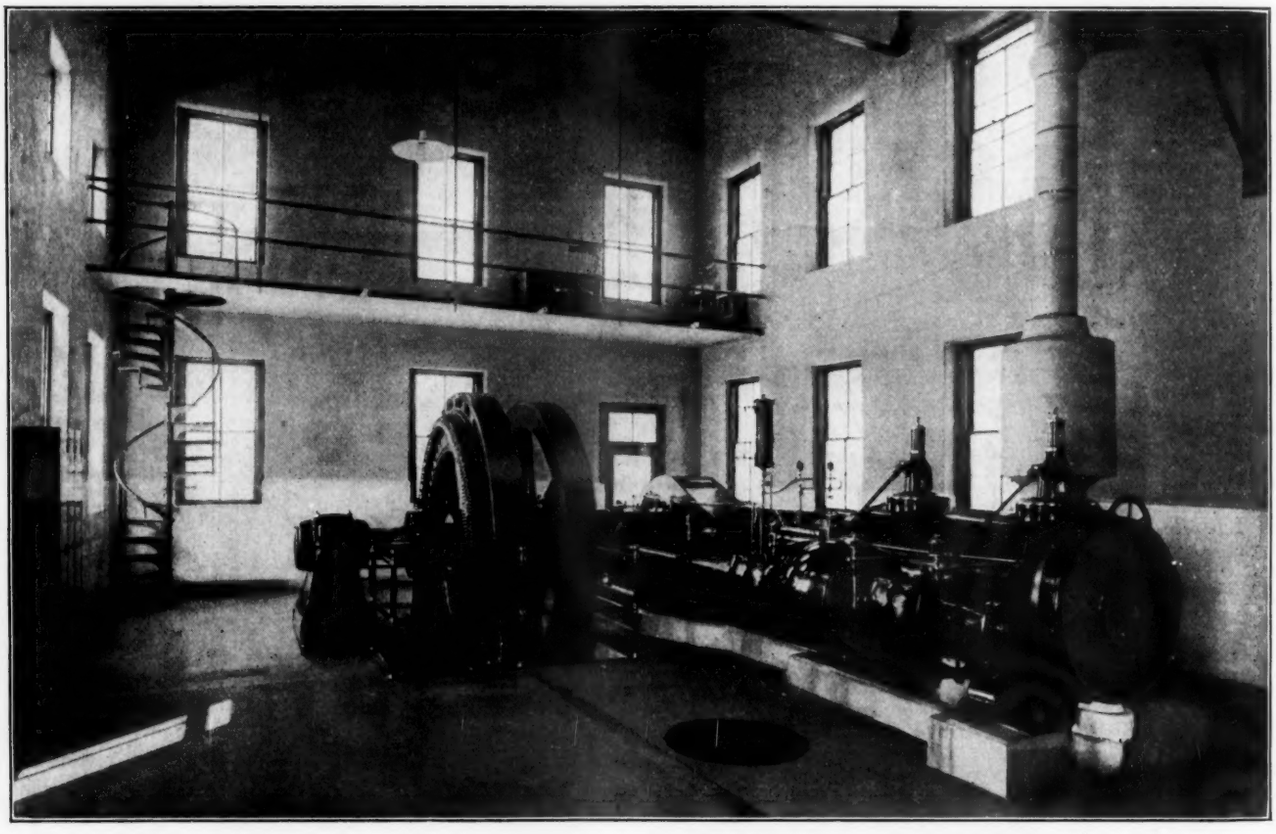


FIG. 3. THE LATEST ENGINE INSTALLED DRIVING A 500-KW. ALTERNATING GENERATOR

PRINCIPAL EQUIPMENT OF THE HUGHES ELECTRIC COMPANY'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Franklin water-tube	306-hp.	Steam generators	Hand-fired, steam pressure, 140 lb.	Franklin Boiler Works Co.
2	Boilers	Return-tubular	150-hp.	Steam generators	Hand-fired, steam pressure, 130 lb.	Western Supply Co.
1	Blower	Sturtevant	30-in.	Forced draft	Motor-driven	B. F. Sturtevant Co.
1	Motor	Direct-current	15-hp.	Driving blower		General Electric Co.
1	Coal conveyor	Bucket	25 tons per hour.	Car and elevt. coal.	Motor-driven	Link-Belt Co.
1	Motor	Direct-current	9-hp. inclosed	Driving coal conveyor	Intermittent	General Electric Co.
1	Pump	Outside-packed	14x9x16-in.	Boiler feed	140 lb. steam	Union Steam Pump Co.
1	Pump	Duplex	8x6x12-in.	Boiler feed	140 lb. steam	Dean Bros. Steam Pump Works
1	Pump	Duplex	7x5x10-in.	Boiler feed	140 lb. steam	Dean Bros. Steam Pump Works
1	Pump	Duplex	5x3½x8-in.	Boiler washing	140 lb. steam, as wanted	Geo. F. Blake Manufacturing Co.
2	Pumps	Duplex	7x9x10-in.	Returns from heating system	Winter months	Dean Bros. Steam Pump Works
1	Air compressor	Locomotive type	9x9x10-in.	Cleaning generators	Steam-driven	Westinghouse Air Brake Co.
1	Car mover	Geared down to drum	Two loaded cars.	Moving coal cars	Motor-driven	Link-Belt Co.
1	Motor	Direct-current	5-hp. inclosed	Driving car mover	230 volts	General Electric Co.
1	Engine	Simple horizontal	12x12-in., 125-hp.	Generator drive	140 lb. steam, 270 r.p.m.	American Engine & Electric Co.
1	Generator	Direct-current	75-kw.	Light and power	270 r.p.m., 230 volts	General Electric Co.
1	Engine	Simple horizontal	16x16-in., 160 hp.	Generator drive	140 lb. steam, 270 r.p.m.	American Engine & Electric Co.
1	Generator	Direct-current	100-kw.	Light and power	230 volts, 270 r.p.m.	General Electric Co.
1	Engine	Simple vertical	20x18-in., 300 hp.	Generator drive	140 lb. steam, 200 r.p.m.	Bates Machine Co.
1	Generator	Alternating-current	200-kw.	Light and power	60-cycle engine drive, 200 r.p.m., 3 phase, 60-cycle	General Electric Co.
1	Engine	Cross-compound, horizontal	14½&25x18-in., 300 hp.	Generator drive	140 lb. steam, 200 r.p.m.	Buckeye Engine Co.
1	Generator	Alternating-current	250-kw.	Light and power	Three-phase, 60 cycle, 200 r.p.m.	General Electric Co.
1	Engine	Simple Lentz	23x30-in., 750-hp.	Generator drive	140 lb. steam, 150 r.p.m.	Erie City Iron Works
1	Generator	Alternating-current	500-kw.	Light and power	Three-phase, 60-cycle, 2300 volts, 150 r.p.m.	General Electric Co.
1	Motor generator	Alternating- and direct-current	100-kw.	Light and power	Three-phase, 60-cycle, 2300 volts, 150 r.p.m.	General Electric Co.
1	Exciter	Motor-driven	35-kw., 125 v.	Exciting generator	Reversible	General Electric Co.
1	Motor	Induction	50-hp.	Exciter drive	Motor driven	General Electric Co.
1	Exciter	Motor-driven	11-kw., 125 v.	Exciting generator	60-cycle, 1200 r.p.m.	General Electric Co.
1	Motor	Induction	20-hp.	Exciter drive	Motor-driven	General Electric Co.
1	Exciter	On engine shaft	80-amp., 125 v.	Exciting generator	60-cycle, 900 r.p.m.	General Electric Co.
1	Transformer	Constant-current	30-kw., 2200 v.	Arc lights	Engine-driven	General Electric Co.

During the heating season there is no consideration given to an economical cutoff in the engine cylinder, as with a 50 per cent. cutoff the terminal pressure is about 60 lb., and as this volume passes into the heating system it gives a momentarily increased velocity 300 times a minute, which is noticeable all through the system, and for this reason good service has been given with as low as 2.5 lb. pressure at the power house.

Simplex condensation meters are used in the system, and steam traps are the standard traps in use where advisable.

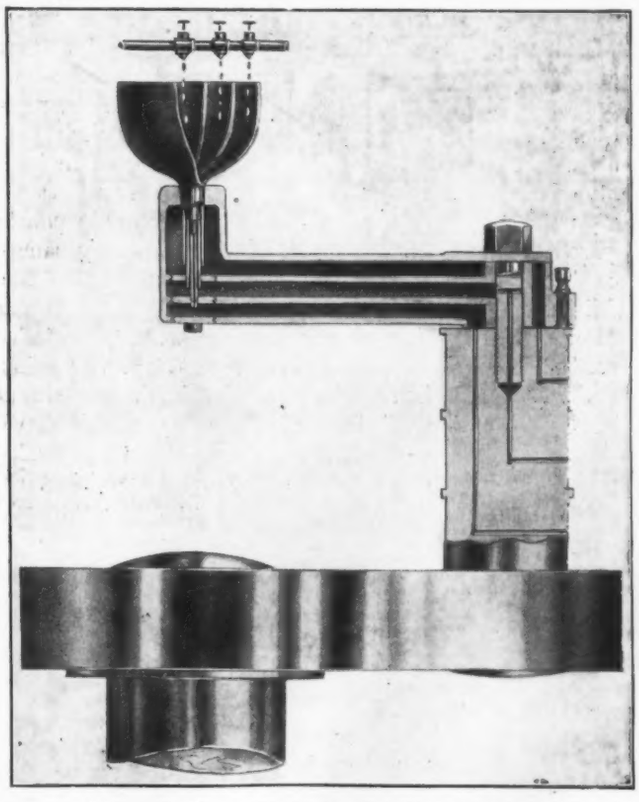
The output of electricity for the month of December, 1914, was 175,495 kw. Of this 25,000 was sent through a 6600-volt transmission line to a railroad shop five miles from the power house. This leaves 150,495 kw. for Bismarck with its 7000 inhabitants, or over 20 kw. for each person per month.

Central Oiler for Vertical Crankpin

Maintaining an adequate supply of oil on vertical crankpins has never been an easy problem, and when the pin carries two or perhaps three bearings, as in the case of angle-compound-centrifugal pumping units, the difficulties are increased.

As an easy solution to this problem Wm. W. Nugent & Co., of Chicago, are offering the central crankpin oiler shown in the accompanying illustration. It consists of a horizontal oiler arm and a funnel to receive the supply of oil. One end of the arm is secured to the crankpin by a bolt, and the receiving end is centered over the vertical shaft. It is evident that while the funnel revolves with the crankpin there is no lateral movement, so that the funnel will remain under the oil feed shown just above. Depending on the number of bearings on the crankpin, the central arm has one, two or three compartments fed through an equal number of concentric funnels.

In the illustration shown the pin has three bearings for the three connecting-rods of a triple-expansion engine. As a consequence there are three compartments in the arm and three funnels, one feeding to each compartment and each compartment feeding a bearing through oil holes bored in the crankpin. By means of the open feeds above the funnels the supply of oil to each bearing can be regulated to suit requirements while the unit is in operation.



NUGENT OILER FOR A VERTICAL CRANKPIN

Feeding through the Blowoff Pipe—About the only excuse for feeding a boiler through the blowoff is that it helps keep the pipe clear. A circulating pipe connected outside of the setting will do as well and allow the boiler to be fed in a safe manner through an internal feed pipe.

Interior Wiring for Lighting and Power Service--V

By A. L. Cook

SYNOPSIS—Power panel-boards; the two-wire direct-current system, and single-phase, two-phase and three-phase systems for power. Full directions for calculating circuits are given, together with illustrative examples. The series concluded.

The choice as to the use of conduit or open wiring for power circuits in factories can be based upon the same considerations as were discussed in connection with the calculations of lighting circuits. If open wiring is to be used, it should be confined to the feeders, which can be located on the ceiling of the room, where they are not exposed to damage; and the branch circuits, which must run in more exposed places, should be placed in conduit. If a combination system of this kind is employed, a suitable bushing such as a condulet should be used at each end of the conduit, since an ordinary iron conduit bushing will not be approved by the inspector. This also applies to the end of the conduit at the motor and at the switchboard. The wire used is the same as for lighting service and is installed under the same rules.

Usually, the branch circuits for a group of motors can best be supplied from a common point at which a panel-board is located. Each branch circuit on the panel-board should be supplied with a knife switch and fuses. Sometimes a switch and fuses in the main busbars of the panel are also provided, but this is not necessary unless other subfeeders are supplied from the panel. Spare circuits should always be provided in every panel-board, the size and number depending upon the probable additions to the motor equipment.

For an installation of any size, one or more switchboard panels must be provided either at the service point or the power station. These panels should contain a circuit-breaker for each feeder and may or may not have a knife switch, depending upon the type of circuit-breaker used. If the board is under expert supervision, as in a power plant, fuses for each feeder may be omitted. The "Code" does not allow a fuse larger than 600 amp. for 250 volts or less, and 400 amp. for 550 volts; so circuits of larger capacity must be protected by circuit-breakers alone. For direct-current service, the carbon-break type of circuit-breaker with overload trip is satisfactory for most uses. For alternating-current service the carbon-breaker type is satisfactory for 110 or 220 volts, but for higher voltages an oil circuit-breaker is much better. For these high voltages it is difficult to get sufficient spacing on the switchboard between adjacent circuits to make the use of carbon circuit-breakers safe. The cost of the oil type is greater, but the resulting saving in the size of switchboard and the more satisfactory operation make its use desirable.

For power feeders it is always best to provide circuit-breakers of some kind rather than to use fuses only, because the fluctuations in load would result in great expense for replacing blown fuses if they were depended upon to open the circuit in all cases of overload. The first cost of the switchboard is, of course, greater, but the saving in replacing fuses and the ability to restore the service more promptly after an overload fully justifies the use of circuit-breakers, particularly in industrial establishments. They can often be used to advantage in protecting individual motors, and of course they must be used for loads exceeding the rating of the largest fuses. According to the "Code," if circuit-breakers are used for smaller loads, fuses must also be used unless the circuit-breakers are under expert supervision, as in a power house.

Two-Wire System

The method of laying out a two-wire system for power is similar to that for lighting. The usual arrangement would be similar to that shown in Figs. 8 and 9 (page 668, May 18, 1915), each panel-board supplying a number of motors. Usually, the two-wire system is employed for direct-current supply, the single-phase system, which also uses two wires, being suitable only for small motors. In the following, therefore, only the direct-current two-wire system will be considered. A two-wire supply for motors may be obtained from a three-wire system by connecting across the outside wires of the system. Sometimes the motors are run from the same feeders that supply the lights on a three-wire system, but this is not desirable because of the voltage fluctuations and greater liability of interruption; and it is therefore best to run separate power and lighting feeders from the supply point.

In locating the panel-boards and switchboards, the same considerations apply as for lighting service, already discussed. The size of wires for the individual motors may be obtained from Table 11 (page 703, May 25, 1915). This table does not take into account voltage drop, which should be calculated by means of the wiring chart, assuming full-load current on the motor. If the drop exceeds about 1.75 per cent. the size of wire should be increased. When the size of wire has been checked in this manner, the fuses for the branch circuit should be chosen, using Table 7 (page 642, May 11, 1915), and fusing to the full capacity of the wire, unless this fuse is the only protection for the motor, in which case 25 or 30 per cent. overload should be allowed.

The total connected load on each panel-board may be obtained by adding together the full current of all the motors on that panel, with a proper allowance for spare circuits. This result is then multiplied by the load factor, an estimate of which must be made carefully; in the absence of definite information 0.75 would be a fair figure to use. After the load has been calculated, the size of the feeder may be determined by reference to Table 7. The voltage drop with the given load should then be determined, and if it exceeds about 3.25 per cent., the size of wire should be increased. If the feeder supplies several panel-boards, or if the motors are connected to various points on the feeder, the drop should be calculated for each section separately and these values added to obtain the total drop. The size of fuses or the setting of the circuit-breakers on the feeders

should be such as to allow the full current capacity of the wires in accordance with the values given in Table 7, irrespective of the actual loads on the feeders.

Three-Phase System

The three-phase system for power supply would employ three wires with equal voltages between them. The four-wire, three-phase system would not be used for motors, the neutral wire being used only when lighting is to be supplied. Ordinarily, three-phase motors requiring three leads would be used, although small single-phase motors might be run from a three-phase system by connecting them across one of the phases. The general arrangement of the branch circuits and feeders would be similar to that for direct-current. Because of the higher voltages which may be used, however, the branches may be made longer and the number of panel-boards thereby decreased.

The sizes of the branch circuits for individual motors are given in Table 12 (page 703, May 25, 1915), which applies to squirrel-cage motors. If motors of the wound-rotor type are employed, the wire should be made large enough to carry at least 1.5 times full-load current, using column A or B of Table 7 (page 642, May 11, 1915), to determine the size. In this case the starting current would be only slightly greater than the full-load running current, consequently fuses selected to protect the branch circuits would also protect the motor, so that the so-called "running fuses" used for squirrel-cage motors could be omitted. All three of the wires should be of the same size, as the currents are equal in all of them.

Table 12 takes no account of the drop in voltage on the wires, therefore this should be checked. If a drop of 1.75 per cent. is allowed between terminals of the motor, as previously specified, a drop of 0.58 of this value, or 1 per cent., can be allowed in each wire. After figuring the direct-current drop for one wire, calculate the alternating-current drop by the method previously described. Take, for example, a 50-hp., 440-volt, 60-cycle, three-phase motor. From Table 12 it will be found that the size of wire should be at least No. 0. The full-load current is 61 amp. If the length of the branch were 100 ft., the direct-current drop would be 1.24 volts for two wires, or 0.62 volt for one wire. Assuming that the wiring is in conduit, it will be found from Table 14 (page 705, May 25, 1915) that the ratio of reactance to resistance is 0.38. With a power factor of 0.85 (see Table 15) the drop factor is 1.07; hence, the alternating-current drop per wire would be $1.07 \times 0.62 = 0.66$ volt, and the total drop, $1.73 \times 0.66 = 1.14$ volts. This is only $\frac{1.14}{440} = 0.002$, or 0.2 per cent., which is much below the maximum of 1.75 per cent. allowed for the branch drop. In this case, therefore, the size of wire is taken as No. 0 because it is the smallest wire which will carry the current safely. If it had been found that the drop was greater than 1.75 per cent., the wire size would be increased as required.

In determining the total load on a panel-board, it is necessary to estimate the maximum load which would have to be supplied at any particular time. As previously explained, this would generally be less than the sum of the full-load currents of all the motors supplied from the panel. With squirrel-cage induction motors care should be taken that the wire is large enough to carry the starting current of the largest motor together with the normal running current of the others. For example, suppose a panel-board supplies the following motors:

One 15 -hp., 220-volt	38.6 amp. full load
One 5 -hp., 220-volt	13.4 amp. full load
One 7.5-hp., 220-volt	19.6 amp. full load
One 10 -hp., 220-volt	26.6 amp. full load
Total	98.2 amp. full load

Suppose that, from a knowledge of the operating conditions, the load factor can be taken at 0.75; the maximum current would then be $0.75 \times 98.2 = 73.6$ amp. There is also a 20-hp. motor supplied by this panel-board, which, when starting; takes 158 amp. The total is the combination of the running current of the several motors and starting current of the 20-hp. motor. The running currents are, however, at a power factor of 0.80 and the starting current at a power factor of about 0.50, hence, they cannot be added together directly; in fact, the total current is less than the sum of these two currents. To add these currents, we have to divide each into a "reactive" part and a "resistance" part by multiplying by the proper factor. The values of these factors for the usual power factors are as follows:

TABLE 16—REACTIVE AND RESISTANCE FACTORS

Power Factor	Reactive Factor	Resistance Factor
1.00	0	1.00
0.95	0.31	0.95
0.90	0.44	0.90
0.85	0.53	0.85
0.80	0.60	0.80
0.75	0.66	0.75
0.70	0.71	0.70
0.65	0.76	0.65
0.60	0.80	0.60
0.55	0.84	0.55
0.50	0.87	0.50
0.45	0.89	0.45
0.40	0.92	0.40

Applying these factors to the example,

Resistance Factor	Reactive Factor
$73.6 \times 0.80 = 59$	$73.6 \times 0.60 = 44.2$
$158 \times 0.50 = 79$	$158 \times 0.87 = 137.5$
138	181.7

The total current is $\sqrt{(138)^2 + (181.7)^2} = 228.2$ amp.

From Table 7 it will be seen that a No. 00 wire would probably be sufficient. If the two currents were added in the usual way the result would be 231.6 amp., which in this case would approximate closely the total current. The nearer alike the power factors of the two currents, the less need there is for employing the exact method given above.

The arrangement of feeders and subfeeders supplying the panel-boards may be laid out in the manner already described. Usually, there will be two or three panel-boards supplied from one feeder, but the number will depend upon the size of the motors and their location. It is desirable to keep the number of feeders a minimum, and on the other hand, it is not wise to use excessively large feeders, because of the great voltage drop. In general, the use of a feeder larger than 300,000 circ. mils is not justified when alternating current is used. The drop on the feeder should be calculated in a manner similar to that employed for the branch circuits, as has already been explained. The current to be used should be the maximum-load current, which is calculated by multiplying the sum of the full-load currents of all the motors (including an allowance for the spare circuits on the panel-board) by the proper load factor. When

a motor is starting there will be a larger voltage drop, but this occurs only for a brief period and can generally be neglected if there are a number of motors on the feeder. When squirrel-cage induction motors are starting the current is large and the power-factor is about 0.50. There would therefore be momentarily a very large drop if the motor starting is large as compared with the other motors. An approximate value of this drop can be determined by neglecting the drop due to the motors running, and calculating the drop for the motor starting alone. The actual drop would then be somewhat greater than this owing to the current taken by the motors running, but would be less than the sum of these two drops. The reason for this is that we have a different power-factor for the running motors and the motor starting, and therefore, the total drop is less than the sum of the two drops.

Two-Phase System

Either the four-wire or the three-wire, two-phase system may be used. If the four-wire system is used, the two windings of the motor are connected across the two phases of the supply; with the three-wire arrangement, the windings of the motor are connected between the outside wires and the common wire. Care must be taken that neither of the windings is connected across the outside wires, as this would subject the winding to an excessive voltage. If the motors are provided with three terminals, the common terminal must always be connected to the common wire. If the direction of rotation is to be changed, this should be done by reversing the connections to the outside lines, keeping the common lead connected to the common wire of the system. If a motor having four terminals is to be connected to a three-wire, two-phase system, the two windings of the motor must be identified, by testing if necessary, and then one terminal of each winding must be connected to the common wire. The three-wire, two-phase system is commonly used, because of the saving in the cost of the circuits. The relative values of voltage and current in the various leads of the two-phase systems have already been explained in connection with the calculations of lighting circuits, and the length and general arrangement of the branch circuits are governed by the same general rules as were given for the other systems.

In Table 13 is given the full-load current and the minimum wire size for two-phase, four-phase, squirrel-cage induction motors, the current given being the value for each of the four wires; the size of wire also refers to each of the four wires. If a three-wire, two-phase system is used the currents in the outside wires and the sizes of these wires are as given in the table, while the current in the common wire is 1.42 times that given and hence the size of this common wire must be increased proportionately. For example, assume a 50-hp., 220-volt, two-phase motor, with a four-wire system; the size of each of the four wires would be No. 0000 and the full-load current 105 amp. With a three-wire, two-phase system the two outside wires would be No. 0000 and each would also carry a current of 105 amp. at full load. When starting, the current in the outside wires is $2.9 \times 105 = 305$ amp., which requires a No. 0000 wire, as given in the table. The starting current in the common wire, however, is $305 \times 1.42 = 434$ amp., and from Table 7, a 400,000-circ.mil wire will be found necessary.

If the wound-rotor type of motor is used, the wire should be sufficient to carry at least 50 per cent. overload continuously. Hence, in the case of this 50-hp. motor the current would be $1.50 \times 105 = 158$ amp. If four rubber-covered wires are used they should each be No. 000, and if three wires are used the outside wires should be No. 000. The maximum current in the common wire would be $158 \times 1.42 = 224$ amp., which would require a No. 0000 wire. In the case of squirrel-cage motors running fuses are required; that for the common lead having a capacity about 1.42 times that for the outside leads.

In the foregoing no account has been taken of the voltage drop, the size of wire given in Table 13 being the minimum size that should be used. It frequently happens that the voltage drop for the branches is small for either three-phase or two-phase systems because of the high voltages used. In any case, however, where there is a possibility of the drop being excessive, calculations of this should be made. In a four-wire system, since the two phases are independent, calculate the circuit as if it were a two-wire, single-phase system, and calculations need be made only for one phase. The drop on one phase can first be calculated by means of the direct-current chart and then the proper correction made for alternating-current by means of Tables 14 and 15. The allowable percentage drop in the branch circuits is about 1.75 per cent. for each phase. For example, take the 50-hp. squirrel-cage motor already mentioned. Assume a frequency of 60 cycles, a power factor of 0.85 and a length of branch circuit of 200 ft. Assuming a four-wire system, the smallest-sized wire which can be used is No. 0000 and the full-load current is 105 amp. Hence, the direct-current drop on one phase would be 2.1 volts. If the wires are in conduit the ratio, from Table 14, is 0.76 and the drop factor is given in Table 15 as 1.27. Therefore, the alternating-current drop is $1.27 \times 2.1 = 2.67$ volts. This is $2.67 \div 220 = 1.2$ per cent., and the size of wire is satisfactory.

If a three-wire system were used, the drop would be calculated as follows: The current in each outside wire would be the same as before, namely, 105 amp. Hence, the drop in each of the outside wires would be 1.05 volts, from the direct-current chart. With alternating current, the drop in each outside wire would be one-half that previously found, or 1.34 volts. Since the currents in both outside wires are the same, the current in the common wire is $1.42 \times 105 = 149$ amp. under full-load conditions. It has already been found that the minimum size of this wire is 400,000 circ.mils, and the direct-current drop for this wire, with 149 amp. flowing, is given by the chart as 0.8 volt. For alternating current, the ratio in Table 14 is 1.49 and the drop factor 1.67 from Table 15. Hence, the drop on this wire is $1.67 \times 0.8 = 1.34$ volts. The total drop on one phase is $\sqrt{1.34^2 + 1.34^2} = 1.9$ volts or 0.9 per cent., which shows the sizes chosen to be correct.

In finding the total load on the panel-board the methods described under the three-phase system should be employed, using the proper load factor and allowing for the starting-current. The drop in the wires may be calculated by the rules given for the branches, since in all cases the loads are balanced. The same rules regarding the combination of currents at different power factors apply.

Increasing Boiler Capacity

By Joseph Harrington

SYNOPSIS—Stirling boiler furnace equipped with Roney stoker remodeled so that the capacity of the boiler was increased from 130 to 309 per cent. of rating. Attention to the dampers increased the draft over the fire. An extension of the furnace arches and the stopping of needless poking of the fire obviated dense smoke.

Having had occasion recently to overhaul a plant for the combined purpose of increasing capacity and decreasing smoke, the results obtained may be of interest to Power readers. The plant in question consists on its steam-generating side of 500-hp. Stirling boilers equipped with Roney stokers having 105 sq.ft. of grate surface. Two 175-ft. stacks serve the two lines of boilers through straight breechings of ample proportions.

This plant had not only been making objectionable smoke, but it was not possible to get from it much more than the boiler rating. Preliminary tests under the former operating conditions gave but 650 hp., or 130 per cent. of rating. These unsatisfactory results were partly the fault of the initial design and partly the result of defective stoker conditions and operation.

As in the majority of smoke problems, this one was founded on the insufficiency of the draft. When the furnace draft was brought up to the point corresponding to normal conditions, combustion was noticeably affected. The actual increase was about 50 per cent., or from 0.33

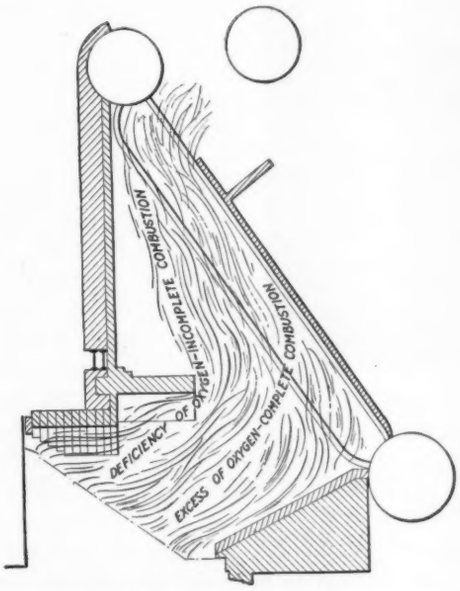


Fig. 1. Diagrammatic Analysis of Original Conditions

to 0.48 in., which under these conditions meant a radical difference in the furnace efficiency.

A part of the draft loss was due to a large damper in the main breeching near the stack. This was originally intended to be operated by a damper regulator, but had fallen into disuse and, although left wide open, was responsible for considerable interference with the gas flow. Its removal was a benefit, and owing to the slight friction loss in the breeching the stack draft was approximated at the boiler dampers. Dampering is usually overdone or underdone, and its influence for good or evil is still but little recognized. With the writer the conviction is gaining that a main breeching damper

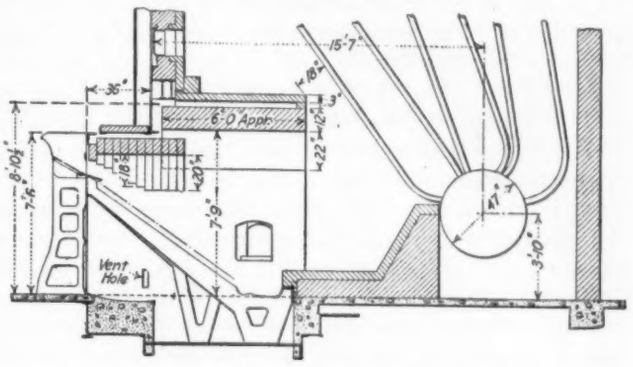


Fig. 2. The Remodeled Furnace

should be used only in certain special cases which must be selected with discretion.

Another heavy loss was chargeable to dampers, only this time it was the individual boiler dampers. Like the majority, these dampers did not close tight enough to exclude air leakage through the cold boilers. This was heavy, and the resultant volume of gases and infiltrated air was so great as to overload the stack. Temperatures were affected and the friction loss increased so that nothing like normal draft intensities were reached until this infiltration was stopped. Some day the idea of having airtight boiler dampers will be seriously proposed and find many advocates.

Sufficient draft in the furnace having been acquired, it was necessary to see that the furnace itself was able to take care of the increased volume of gases evolved at the higher capacities. An analysis of the furnace conditions is shown in Fig. 1. The cause of the smoke is apparent at a glance. Much of the volatile matter was slipping around the end of the short arch, across the chamber above, to the upper end of the first bank of tubes. The heavy excess of air at the lower end of the fire was filling the flame spaces of the front bank and holding away the hot gases that might otherwise have come into contact with the tubes. At the upper end of the furnace, temperatures were so far down that further combustion was impossible. The rest of the story was readable at the top of the stack.

Just as the cause became apparent, the remedy was obvious. In Fig. 2 is shown the furnace designed for this case. Extended comment is unnecessary. A more liberal supply of air was provided under the Roney arch and the proper fuel-bed thickness for different ratings was determined.

An important item was the handling of the stoker. The men seemed to think that the more they poked the better they did. This was all changed and the stoker allowed to do the work. Intelligent and effective coöperation on the part of the chief engineer resulted in the develop-

ment of skilled firing, with less distress to the men and far better results from the stoker. It became apparent immediately that the stoker would do the work if left alone, and today it is the practice to poke only when there is special reason for it. Poking is done locally and as little as may be required to trim the fires in that particular spot.

Capacities up to 243 per cent. of rating were obtained for eight-hour periods, with an average increase in efficiency of 8 per cent. The highest hour showed 1545 hp., or 309 per cent. of rating. This was done without any injury to the stoker or furnace and without objectionable smoke. Furnace temperatures naturally were high, owing to the high rate of combustion and the reduction in excess air. On the high rating test an average of 13.17 per cent. CO_2 was obtained at the end of the flame and 11.96 per cent. at the damper. Moreover, practically all of the combustion took place in the *furnace,* which besides producing a high temperature was favorable to the absorption of the heat, the completely burned gases sweeping over the entire heating surface. The damper draft was 1.28 in. and the furnace draft 0.578 in.

While reference was just made to the highest capacity test of the series, the average was well above double rating. To give a better idea of the principal results, a table containing some of the averages is appended.

SUMMARY OF PRINCIPAL RESULTS

Test No.	Uptake Draft, In. of Water	Fur. Draft, In. of Water	Flue Temp., Deg. F.	Coal per Sq.Ft. of Grate	Capacity, Hp.	Evap. F. and A. as Fired, Lb.	Per Cent. Excess Air	Fur. and Grate Eff.	Combined Efficiency
4	0.881	0.451	728.53	39.46	1039.2	8.654	83.0	93.3	77.30
5	0.885	0.447	663.20	48.70	1039.0	7.010	65.0	89.6	63.36
6	0.936	0.447	694.30	47.96	1080.0	7.408	67.0	90.2	66.90
7	0.619	0.313	677.22	46.40	1076.9	7.621	65.3	84.6	64.40
8	0.702	0.356	741.25	43.36	944.0	7.400	54.5	87.8	68.30
9	1.280	0.578	747.20	55.70	1188.0	6.774	66.5	88.3	61.90
10	0.891	0.449	733.60	53.57	1214.1	7.446	42.0	93.0	65.18

Preventing Corrosion From Electrolytic Action

To prevent the electrolytic corrosion of boilers and similar vessels, the Cumberland Engineering Co., of London, Eng., has developed a rather interesting apparatus. Essentially, it consists of anodes that are insulated, that is, connected to the boiler shell by an insulated bolt, and that form the positive side of the circuit, while the shell itself is connected to the negative side, making it the cathode. The aim is to pass low-tension current, which may be regulated by resistances fixed on a switchboard or similar place. The current is supplied at from 6 to 10 volts, and an ammeter mounted on the board enables the operator to tell how much current he is sending through.

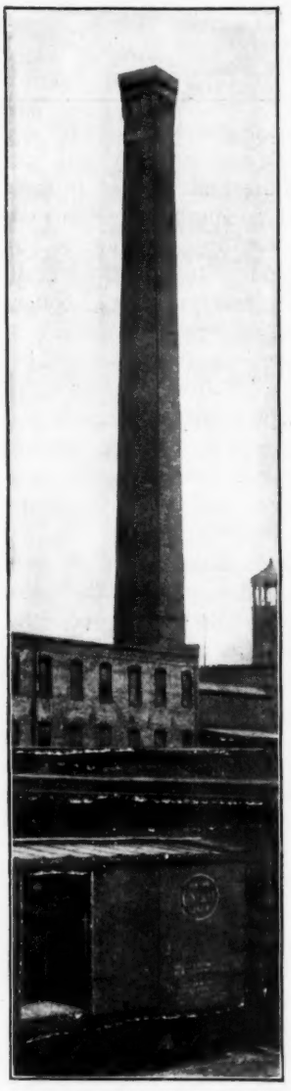
The elements of the water contained in the vessel are electrically charged when the current is on, and at the anodes there assemble the anions. When this occurs a film of hydrogen is said to form over the immersed portion of the vessel, thus protecting the latter; the oxygen, acid and other corrosive agents being attracted to the iron anodes, which become reduced just as zinc slabs do and must be renewed.

The claim is made that hydrogen, in being liberated from the surface of the metal in bubble form, tends to take from the surface any scale or other matter that may be clinging to it. This claim, then, presupposes that water must get under the scale, for the hydrogen bubbles must have their source in the water and not in the metal.

The development of this elaboration on the zinc-plate method of combating corrosion will be watched with interest.

A Brick Chimney Which Floats

In 1884 the Schlichter Jute Cordage Co., of Frankford Junction, Penn., started to put up a 200-ft. brick chimney, when it was found that the ground upon which the chimney was to stand overlay a quicksand into which a ⅜-in. iron rod would settle, if released, beyond hope of recovery. Mr. Herman Dock, to whom the design and construction of the chimney had been intrusted, simply cast a block of cement 30 ft. square and 5 ft. in thickness in an excavation, where it was desired that the chimney should stand, and built the chimney upon this floating block without any piling or other support. The chimney is square, as shown in the accompanying photograph, 13 ft. at the base and 11 ft. 6 in. at the top, and is composed of solid masonry without any core, the internal dimensions being 6 ft. at the bottom, and, contrary to the usual practice, 6 in. greater at the top. Its height is about 200 ft. and its total weight something like 1000 tons. It sways freely in the wind, and its movement may be felt by putting the hand between it and the engine-room wall, but it has suffered no permanent departure from the vertical. Four hundred barrels of Portland cement were used in casting the floating base; 1200 hp. of boilers are attached.



THE FLOATING CHIMNEY

Steam Consumption in Pumping—The common type of direct-acting pump, so much employed in mining, is well known to be wasteful in respect to the consumption of steam. This is owing to the necessity of using steam at full pressure throughout the entire length of stroke. Only a comparatively few pumps are designed to use steam expansively and these are not adapted to the commonly high lifts in mining. Steam consumption, in pumping, ranges from 10 or 15 lb. per i.hp. per hr., in triplex, flywheel pumps when run condensing, to an average of 150 lb. per i.hp. per hr. in direct-acting pumps. The consumption of steam, in pumps of the latter type, varies from 100 to 200 lb. per hp. per hr., depending on the speed of the pump and its condition. In this class of pumps, the consumption of steam is less as the speed is increased.—"Coal Age."

Some Notes on Elevator Pumps

By Thomas J. Rogers

The pump or pumps used in connection with a hydraulic elevator system should be of sufficient capacity to deliver the maximum quantity of water required promptly on demand. There are times during the day when the elevator system is heavily and quickly loaded and the water required is considerably more than the average quantity per minute pumped during the rest of the day. A pump large enough to care for these rush periods at a slow speed would, of course, be uneconomical during light-load periods. A common practice is to have a relay pump which may be run together with the main pump when the quantity of water required exceeds the capacity of one unit.

The crank and flywheel pumping engine for large elevator installations is superior in steam economy to other types, but is not available in small units, because it cannot be stopped and started automatically; and if kept running constantly it will pump through a bypass part of the time and much of the possible economy will be lost.

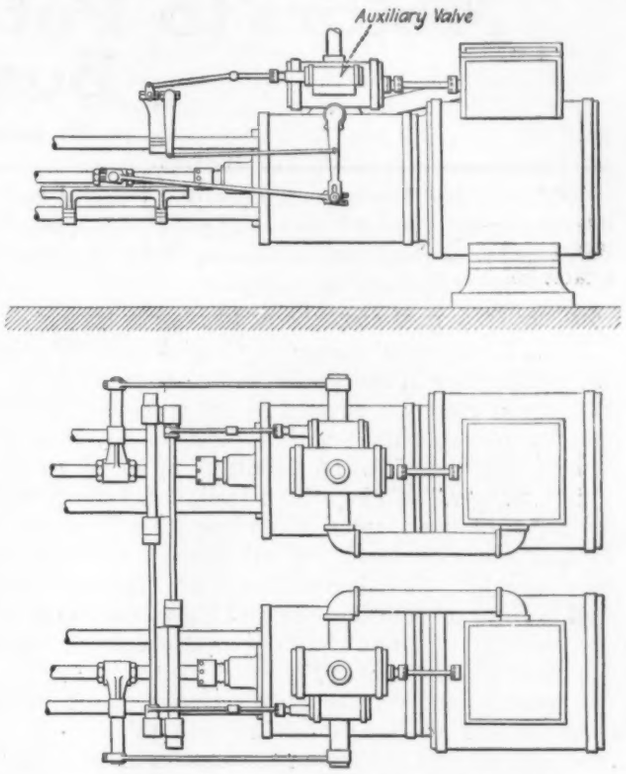
The writer has obtained good results with a compound separable duplex pump, in which either side may be operated independently of the other or both run together in duplex. This machine can be operated intermittently according to the demands of the service, and it is under governor control; it can be stopped when the proper pressure has been established and there is no demand for water, and started quickly when a slight drop in pressure occurs in the tanks due to the operation of the cars. When running duplex each of the two steam ends has control of the closure of its own steam valves, and the opening of them is controlled by the opposite engine.

The stroke is long and constant and the valve area large, though each valve is of small diameter. This type of pump closely approaches the economy of the crank and flywheel pumping engine, requires less attention, and the cost of operation and repairs is so much less than for the crank and flywheel type that, considering first cost, cost of foundations and installations, it is quite as economical an installation. It has the further advantage that it can be run either duplex or simple, one side only being operated during the periods of minimum demand, such as for night service, Sundays and holidays. This feature is particularly convenient when it is necessary to examine the piston packing, valves, etc., or when making examination or repairs to the steam end, as one side may be operated while such work is being done to the other side. This, of course, is impossible with the ordinary duplex pump or the crank and flywheel engine.

The maximum economy of any steam engine is obtained only when it is running at its full normal speed. In the case of a duplex or a crank and flywheel pump operating during the periods of minimum demand, the engine is necessarily run much below this speed; but in the case of the separable duplex type described, one side is shut down and the other operated at its full normal speed, meeting only the decreased demand.

On the steam end the method of connecting up is simple. It is well to use one valve in the main steam line and one in each of the branches, the exhausts being brought out and connected together in the most convenient manner to suit the situation. The side elevation shows the auxiliary steam chest and the control valve fitted to the side of the main steam chest, and by means of which the proper "timing" or duplex action of the two pumps is secured by movement of the piston in this auxiliary chest through the duplex levers and rods shown. Working duplex, this machine operates positively and is a true duplex, but not subject to short-stroking. Throwing the pump in or out of duplex is the work of but a minute, requiring only the pushing in of the handles of the control valve on the auxiliary chest on both sides to throw the pump into duplex running, or throwing them out of duplex by merely pulling these handles out.

When the pump is running as a duplex machine and it is desired to shut down one side, both handles are pulled out, leaving the pumps running for the minute as two separate units, then by shutting the valves on one side



Elevation and Plan of Elevator Pump

that pump is cut out, while the other side continues to operate as a single-cylinder, double-acting pump.

The water end should be fitted with two valves next to the cylinders which should connect to the main pump discharge through a tee. In case of running one side and opening the other cylinder for repairs, renewal of valves, etc., the closing of the valve next to the cylinder out of commission would isolate that one on the discharge side. The suction may have two separate lines at the pump.

In fitting an elevator pump, no matter what type, it is well to put relief valves on the water cylinders so that if by any chance the pump should be started with the stop valve in the main discharge line closed, excessive pressure will not be created in the pump cylinders. In such cases the relief valves usually discharge into the surge or the suction tanks.

Pumps used for delivering water up to about 250 lb. pressure into a closed tank, as on hydraulic-elevator systems under air pressure, are usually controlled by a pump

pressure regulator. Where the pressure carried is above 250 lb. and up to an exceedingly high pressure an accumulator is used to govern the speed of the pumps.

Owing to the nature of the service being intermittent, the water on the suction side should flow to the pump by gravity with a head of from four to five feet over the under side of the discharge valves.

A necessary fitting to the water end of a hydraulic elevator pump is a suction air chamber. While the machine is in operation the water is rushing into the pump with considerable force, and should the regulator act and the machine stop at the end of its stroke, the water will continue to rush in with force enough to raise the suction valves from their seats and allow them to fall back with a loud pound. The pump air chamber prevents this.

The discharge air chamber should be kept at least three-quarters filled with air under pressure, and by application of a gage-glass its contents can be seen at a glance. A good method of recharging the discharge air chamber with air, should it become filled with water, is to run a line from the top of the air chamber to an air compressor with a check valve in the line close to the air chamber. If an air compressor is not available the best way is to attach an aërating valve in the suction line between the suction valve and the pump, and by running with this valve open to the atmosphere and the suction valve closed or partly closed, the machine will draw in air and force it into the discharge air chamber.

Motors to Put Engines Out of Business

By Bill B. Banger

SYNOPSIS—The alarming prospect revealed by the clipping (and it is an actual one that is reproduced) from the Eureka ————. What it really shows is central-station enterprise.

While I was loafin' around my engin' room th' other day a feller blew in and started to look over th' shebang. He seemed mighty interested in th' generators, peeked into 'em here and there until I began to fear it would be necessary to send for an ambulance or an undertaker.

"Mr. Banger," said he after a spell, and I pretty nigh lost my equilibrium, seein' it's so long since I was called anythin' but Bill, except by th' firemen, who call me most anythin'. "Mr. Banger," says he, "this electricity stuff is all to th' futurity; you and I may not live to see any particular progress along electrical endeavors, but it will come, it's sure to come!"

I hadn't given th' feller much attention more'n to see he didn't get electricuted or fall into th' flywheel or some such minor accident, but his remarks made me hesitate in th' even tenor of my ways and squint at him over th' top of my glasses, which I have to wear on special occasions. A man with such broad perception of th' general trend of things, especially along electrical lines, was worth lookin' at a second time, by heck. Somehow or other, I had got th' idea that some considerable progress had been made in th' electrical generation and transmission of power and was somewhat surprised to hear that it wasn't likely that th' stranger and myself wasn't liable to live to see any material progress in electrical matters, leastwise not of a startling nature. Seein' I didn't have anythin' to say, I kept my mouth shut for once and waited for the next spasm.

"You'll be surprised, Mr. Banger," said he, "to see how electrical matters are progressin' in our town of Eureka. Of course, we don't come up to New York, but when you compare th' difference in size we are a close second, and lots of people are beginnin' to tumble to th' fact that we are on th' map. Of course, our trolley service ain't as big as what you have in this here city, but we get there just th' same.

"And our great white way is some class, I can tell you. One big electric light in front of th' grocery store and two in front of th' movin' picture sho', all on th' main street. Some town, I tell you."

Before I had a chance to say anything he started off again until I thought he was wound up for good. "I'll tell you, electricity is goin' to work havoc with th' steam and gas engin's and I can prove it." Whereupon he pulled out a newspaper clippin' and handed it to me to read. Here is what it said: [A reproduction of the clipping is shown herewith.—Editor.]

WILL USE ELECTRIC POWER.

Two Large Eureka Institutions Will Use New Power.

Electricity is rapidly replacing steam and gasoline engines as a means of power. The Eureka Roller Mills has placed an order with the Eureka Light and Power Company for a 20 horse power motor. This large motor will soon be here and will be given a thorough tryout by the milling company. As soon as the motor has proven to the satisfaction of the manager that it will do the work expected of it, the engine now used will be discarded.

The Home Steam Laundry will install five electric motors. These are now here and will be connected up in a few days. This order consists of five motors—two 5-horse, two 2-horse and one on-half horse. These five motors will do the work now done by a steam engine and are supposed to be much more economical. The steam engine, however, will be retained in order to furnish steam and hot water for laundry purposes.

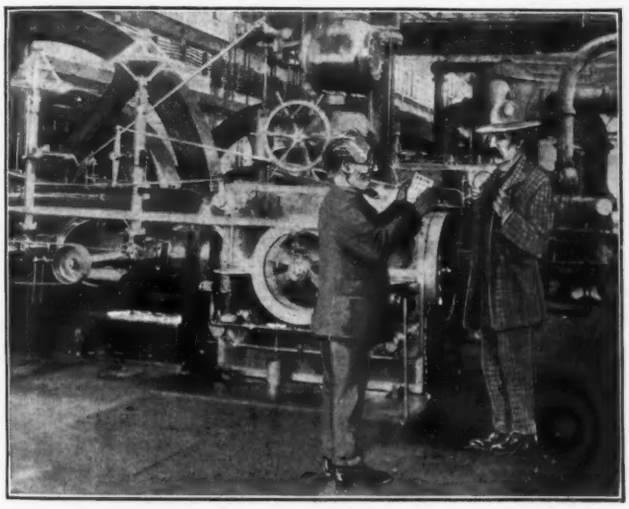
Well, I swan! When I finished readin' that clippin' I felt like putty nigh goin' over in a heap on th' engin'

room floor. Just to think of a large 20-hp. motor bein' given a tryout to see if it would act satisfactorily! If th' motor does come up to th' scratch—and I calculate that there might be some doubts about it, seein' it's such a monster—I suppose th' large 20-hp. steam engin' what has been runnin' th' mill will have to go.

My visitor said there wasn't any more progressive parties in th' town than th' mill and th' laundry people, but I wondered how th' laundry people figures th' thing out that th' 15½ hp. in motors was goin' to be a gain, when they were goin' to keep th' old boiler—no it's th' engine—to furnish steam and hot water for laundry purposes.

It looks to me as if th' roller mill and laundry people wern't th' only ones that had their eyes peeled. It seems somewhat like as if the central-station evil, as it's sometimes called, was abroad in th' midst of Eureka and that th' business solicitor was a feller what was on to his job.

When I finished readin' th' clippin' Mr. Man was standin' with his thumbs in th' armholes of his vest, and



I Swan! When I Finished Readin' That Clippin' I Pretty Nigh Fell Into a Heap on th' Engin'-Room Floor

was teterin' back and forth on his toes and heels like a circus performer, and lookin' prouder nor a pussy cat with a litter of little toms.

"Some units," says he, "and it all goes to show that our people are awake to th' savin' what can be had by usin' electricity."

"That's as may be," says I. "Of course, I don't know how old that 20-hp. engin' is or how much steam it chews up per horsepower developed, which might be from 17 or 18 up to 60 or 70 lb. per horsepower, it all depends on th' engin' and th' engineer what has been nursin' th' thing.

"If th' engineer at th' mill is goin' to be kicked out in th' cold and th' steam plant shut down, and if th' charge for electrical energy is low enough and if th' steam engin' was a steam eater, why there is a chance—mind, I say a chance—that th' mill people will come out at th' big end of th' horn. If th' engin' is a good one and th' engineer knows his business, and if th' cost of juice ain't right, then I would advise them mill fellers to keep cool and not be in a hurry to throw th' engin' and boiler out onto th' scrap heap. They might be glad to start 'em up again when th' contract with th' electric company runs out," says I.

Th' stranger kinder looked stalled awhile and said he didn't think any mistake had been made and that even if it did cost more to run th' mill by motor than by steam, it didn't matter much, but showed that they were progressive anyhow. "Don't you know that th' introduction of all new innovations is prone to result in financial losses, more or less?" says he.

"Well," says I, "there is somethin' in what you say and so we'll let th' mill proposition drop and take a whack at th' wash factory. Accordin' to th' clippin' th' boiler—no th' engin' but we'll assume it's th' boiler—is to be hung onto and kept in th' business. It will take just as many men to run that boiler for keepin' up steam and heatin' water as it did to run th' boiler and th' 15½-hp. engin'. Th' only difference in th' operatin' cost will be in th' savin' of fuel that was necessary to burn to keep th' engine' goin', and a few quarts of engin' oil once in a while. Now, accordin' to all precedents, it's goin' to cost more to run them motors than it would to buy coal to run th' engin', unless a mighty low rate for juice has been made. I would give th' wash fellers th' same advice what I handed out about th' mill. It won't be a mite foolish for 'em to keep th' engin' right to home, for there have been lots of cases where engin's have been started up again after havin' been put on th' shelf while th' company was learnin' wisdom by experience and handin' out dollars to th' central-station fellers."

When th' feller was gettin' ready to get out, I gently put my hand on his shoulder and told him that what looks big in one place was less than commonplace in another, especially in electrical matters, and that although th' two enterprises in Eureka had put in a total of 35½ hp. in motors and while it might be a big thing in that town, it was not a criterion that all steam and gasoline engins were goin' to be put out of business all over th' country. A 20-hp. motor may be some stunt in Eureka, but it would hardly be able to shift th' brushes on th' 3750-kw. shunt-wound, direct-current generator that was built about a year ago.

"Down in th' so called sleepin' city of Philadelphia," says I, "they have a 35,000-kw. turbin' generator and out in Chicago they have a small 25,000-kw. unit. Out on th' Mississippi River there is a plant that will, when it's finished, generate about 300,000 hp., and 150,000 hp. is now in, and out on th' Pacific coast they have an electric transmission line 400 miles long, and one line out that way carries 150,000 volts every day, by heck.

"Just let me give you a little tip," says I. "Electricity may be for futurity, as you said, but it's a mighty big proposition now, and unless both of us turn up our toes pretty dinged soon we are goin' to see some more big stunts pulled off. They won't cause much stir, because things move so fast these days that it takes somethin' more than an ordinary earthquake to make us take notice—we take it as a matter of course and don't give a ding.

"When th' next feller in Eureka puts in a 25- to 30-hp. motor you won't pay much attention to it, for you'll be gettin' used to progress and take it as a thing to be expected. On th' other hand don't be surprised if th' mill and laundry fellers go back to th' steam engin' just as soon as they get th' chance. Goin'? Well, so long."

Most Economical Vacuum for Turbines

By Winslow H. Herschel

SYNOPSIS—Discusses the conditions which influence the degree of vacuum which it is best to carry on a turbine.

It is unfortunate that the word "economy" is used for steam consumption, as a low water rate does not necessarily mean economy at the coal pile. That depends upon the gain in power as compared with the increased cost of obtaining higher pressures, superheat or vacuum. The whole question of cost of power is complicated and depends to such an extent upon local conditions that it is impossible to find any general formula for obtaining power at the lowest cost. Without considering variations in pressure and superheat, factors which mainly depend

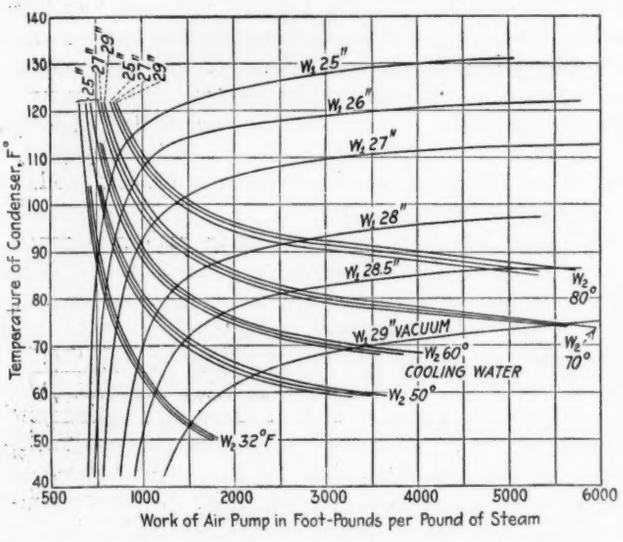


Fig. 1. Variations in Work of Dry and of Wet Air Pumps for Assumed Air Leakage

on whether a high first cost is more than offset by low operating expenses, let us confine our attention to the question of vacuum, since the cost of producing a vacuum may be measured in units of power and subtracted from the power of the prime mover to give net or effective power. What one wishes to know is what vacuum will give the maximum effective power.

In steam engines, as is well known, the large size of cylinders required and the great amount of cylinder condensation prevent high vacuums from being truly economical or from giving a very low water rate, so that a vacuum of about 26 in. is as high as it is advisable to go. With steam turbines, on the other hand, it is possible to have the steam at exhaust nearly at the point of saturation, so that the question of condensation is of minor importance, and it is feasible, at least in large-sized turbines, to design the blading to take care of the highest vacuum which an air pump can produce. The most economical vacuum is therefore not determined by the same considerations as in the case of steam engines.

To simplify the matter it will be assumed that the cooling water is delivered to the condenser by gravity, and neglecting the cost of the cooling water and the higher cost of an installation capable of producing a higher vacuum, we shall consider merely the power required to produce the vacuum by pumping the cooling water, condensed steam and air from the condenser out against the atmospheric pressure. This problem has been investigated by Stodola ("Die Dampfturbinen," Fourth Edition, p. 548) where he has assumed that the ratio of cooling water to condensed steam is equal to 50. It is obvious, however, that this is only an average or special case, since the higher the temperature of the cooling water, the greater will be the amount of it required to produce a given vacuum. In fact, the temperature of the cooling water available is often the deciding factor as to whether a steam turbine or some other form of prime mover shall be adopted, and frequently leads, in warm climates, to the substitution of the Diesel engine.

The presence of air in the condenser is mainly due to leakage through the stuffing-boxes. According to tests of George A. Orrok ("Journal A. S. M. E.," 1912, p. 1625), while the volume of air in city water at 52 deg. F. was over 4 per cent., this had been reduced to less than 1 per cent. in the feed water with a temperature of 187 deg. F. He found that with turbines of from 5000 to 20,000 kw. capacity, the amount of air discharged by the dry-air pump, at atmospheric pressure and temperature, varied from 1 cu.ft. per min., with the units in the best condition, to 15 or 20, when ordinary leakage was present, or to 30 to 50 when the units were in bad condition. These figures are checked by Stodola's statement that we may ordinarily expect the air to amount to 1.5 to 2.5 cu.ft. per min. for each 1000 kw. capacity.

Thomas C. M'Bride (Power, July 14, 1908, p. 74) points out that manufacturers of condensing apparatus for steam engines usually allowed for handling from 4 to 6 volumes of air per 10,000 volumes of exhaust steam, and gives results of tests in which the amount of air varied from 18 to 74 volumes. These figures are based on a 26-in. vacuum and a hotwell temperature of 110 deg. F. He also states that the amount of air to be handled should be as definitely specified as the amount of steam, or else the air-pump manufacturers should not be held responsible for the vacuum obtained.

In a more recent article, Prof. C. L. W. Trinks (*Proceedings* of the Engineers' Society of Western Pennsylvania, June, 1914, p. 497) gives the weight of air normally expected by builders of air pumps as 0.25 to 0.50 per cent. of the weight of steam. This would indicate a growing recognition of the large amount of air usually present in a condenser and its marked effect in reducing the vacuum which would otherwise be obtained.

In the calculations three different amounts of air leakage have been assumed—0.31, 0.62 and 0.93 per cent. of the weight of steam. These amounts correspond respectively, to about 20, 40 and 60 volumes of air per 10,000 volumes of exhaust steam, when reduced to M'Bride's basis of comparison, or to approximately 15, 30 and 45 cu.ft. per min. for every 1000 kw. capacity.

Comparing our assumed values with those of the authorities quoted, we may say that the smallest amount of air could be obtained with stuffing-boxes in the best condition, the second amount under ordinary conditions, while the third value might be reached and exceeded with the stuffing-boxes in poor condition.

The work done by the air pump is found as follows: If p is the pressure in the condenser in pounds per square foot and p_s the steam pressure as given in the steam tables for the temperature of the condenser, then the pressure of the air in the condenser is the difference between these two pressures. Therefore, the weight per cubic foot of the air is $D = \frac{p - p_s}{RT}$, where T is the absolute temperature (that is, 459.6 plus the temperature in degrees F.) of the condenser, and R is the air constant 53.34. Let D be the weight per cubic foot of steam at temperature T. Then, if we have C pounds of air with each pound of steam condensed, the weight of mixture to be pumped for each pound of steam is $C\left(1 + \frac{D_1}{D}\right)$. The theoretical work to compress this weight of mixture, that is, the work required with an ideal air-pump efficiency of 100 per cent., will be

$$W_1 = C\left(1 + \frac{D_1}{D}\right)\frac{k}{k-1}RT\left[\left(\frac{p_b}{p}\right)^{\frac{k-1}{k}} - 1\right]$$

where p_b is the barometric pressure and k is the exponent for the adiabatic compression of the mixture of steam and air which may be taken equal to 1.41. To get the total work of the air pump, $W_1 + W_2$, we must add to W_1 the work required to pump out the cooling water, which is

$$\frac{m\,(p_b - p)}{D_2} = W_2$$

where D_2 is the weight per cubic foot of the water and m is the weight of cooling water per pound of steam condensed. The value of m may be found from the equation

$$m = \frac{H - t_1}{t_1 - t_2}$$

where H is the total heat of the steam, t_2 is the temperature of the cooling water, and t_1 is the temperature of the condenser. The heat H is determined by the vacuum, t_2 may be estimated approximately for any given locality, and t_1 remains to be determined so that the sum of W_1 and W_2 shall be as small as possible. It may make the matter clearer if we imagine two separate pumps—the dry-air pump which does the work of compression, W_1, and the wet-air pump which does the work of pumping, W_2. Then it is evident that with a given temperature of cooling water and a certain amount of air leakage, the vacuum may be increased to the desired amount by increasing the work of either of the two pumps; that is, the vacuum may be improved by decreasing the temperature of the condenser by the use of more cooling water, or by decreasing the pressure by speeding up the dry-air pump. For a given vacuum, W_1 will increase with a rise in the temperature of the condenser, while W_2 will decrease, and at a certain condenser temperature, depending on the vacuum and on the temperature of the cooling water, $W_1 + W_2$ will be a minimum.

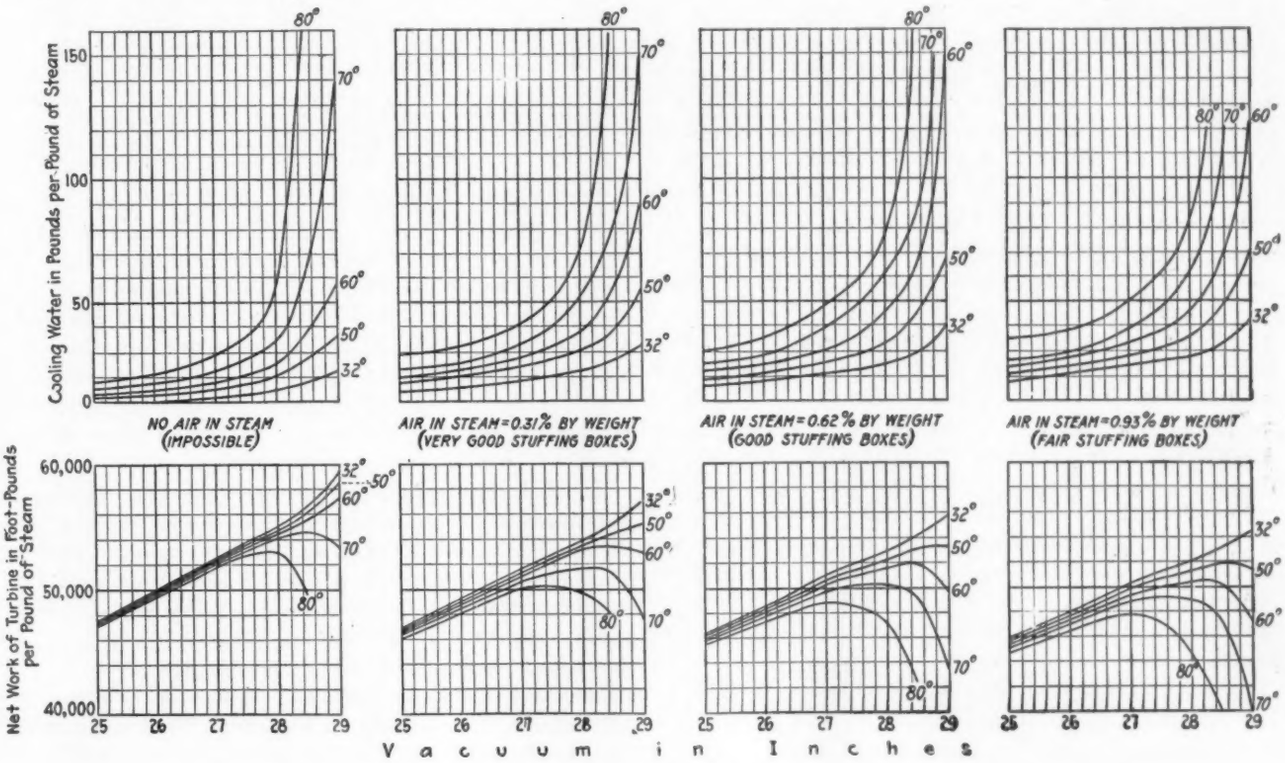

Cooling Water in Pounds per Pound of Steam
Net Work of Turbine in Foot-Pounds per Pound of Steam
NO AIR IN STEAM (IMPOSSIBLE)
AIR IN STEAM=0.31% BY WEIGHT (VERY GOOD STUFFING BOXES)
AIR IN STEAM=0.62% BY WEIGHT (GOOD STUFFING BOXES)
AIR IN STEAM=0.93% BY WEIGHT (FAIR STUFFING BOXES)
Vacuum in Inches

FIG. 2. GRAPHICAL PRESENTATION OF DATA CONTAINED IN TABLES

In Fig. 1 are shown variations in W_1 and W_2 for an assumed air leakage of 0.62 per cent. of the weight of steam. As W_1 is proportional to the leakage of air, it is easily found for any other amount. Since W_2 varies with the temperature of the cooling water (though W_1 does not), different sets of curves are shown for temperatures of 32, 50, 60, 70 and 80 deg. F., each set consisting of three curves for vacuums of 25, 27 and 29 in. By means of this diagram we have obtained by trial the condenser temperatures which would make the total

air-pump work a minimum under various conditions. The results are shown in Table I. With the temperature of condenser known, we are in position to find values of m which are also given in Table I and shown in Fig. 2.

TABLE I

Leakage of Air, in per Cent. of Weight of Steam	Temperature of Cooling Water, Deg. F.	Temperature of Condenser, Deg. F.	Vacuum, Inches of Mercury	Total Work of Air Pump, in Ft.-Lb. per Pound of Steam	Value of Ratio, m
0.00	32	77	29	710	21.8
		86	28.5	580	18.2
		98	28	460	14.8
		113	27	370	12.0
		124	26	340	10.6
		132	25	330	9.7
	50	77	29	1180	36.3
		86	28.5	870	27.3
		98	28	630	20.4
		113	27	470	15.5
		124	26	380	13.1
		132	25	360	11.8
	60	77	29	1900	57.8
		86	28.5	1200	37.7
		98	28	820	25.7
		113	27	560	18.3
		124	26	430	15.2
		132	25	390	13.5
	70	77	29	4500	140.0
		86	28.5	1950	61.3
		98	28	1110	34.9
		113	27	700	22.6
		124	26	530	18.0
		132	25	440	15.6
	80	86	28.5	5350	164.0
		98	28	1740	54.3
		113	27	910	29.5
		124	26	660	22.0
		132	25	530	18.7
0.31	32	63	29	2150	32.1
		71	28.5	1560	25.6
		78	28	1280	21.7
		87	27	1000	18.2
		96	26	840	15.6
		105	25	725	13.7
	50	68	29	3300	55.0
		77	28.5	2120	36.7
		83	28	1650	30.2
		92	27	1210	24.7
		100	26	990	19.9
		106	25	720	17.8
	60	71	29	4820	89.8
		79	28.5	2740	52.3
		86	28	2000	37.9
		96	27	1410	27.5
		104	26	1120	22.6
		113	25	930	18.7
0.31	70	76	29	8220	164.0
		83	28.5	4010	75.8
		89	28	2670	52.2
		100	27	1700	32.8
		109	26	1280	25.2
		113	25	1060	23.0
	80	86	28.5	7750	164.0
		94	28	3930	70.0
		104	27	2110	41.0
		111	26	1530	31.8
		114	25	1280	29.0
0.62	32	57	29	3010	40.0
		67	28.5	2260	28.7
		72	28	1860	25.1
		77	27	1440	22.4
		90	26	1200	17.4
		95	25	1020	16.0
	50	65	29	4600	66.5
		73	28.5	2980	43.2
		80	28	2310	33.1
		90	27	1710	25.0
		96	26	1390	21.7
		104	25	1190	18.5
	60	70	29	6820	99.9
		76	28.5	3700	61.9
		84	28	2760	41.4
		93	27	1960	30.1
		99	26	1560	25.6
		106	25	1300	21.7
	70	73	29	11040	328.0
		82	28.5	5440	82.8
		86	28	3570	61.8
		95	27	2300	39.6
		105	26	1770	28.3
		109	25	1450	25.5
	80	86	28.5	10040	165.0
		93	28	5540	75.8
		100	27	4890	49.4
		108	26	2040	35.4
		113	25	1680	30.0
0.93	32	55	29	3840	42.7
		62	28.5	2880	32.8
		68	28	2380	28.0
		73	27	1840	24.5
		77	26	1530	21.5
		93	25	1310	16.5
	50	64	29	5760	70.8
		71	28.5	3730	47.3
		78	28	2920	35.5
		85	27	2150	28.6
		91	26	1760	24.5
		95	25	1480	22.4
	60	68	29	8440	123.8
		75	28.5	4720	66.0
		82	28	3450	45.1
		88	27	2440	35.7
		96	26	1960	27.8
		104	25	1630	22.6
	70	72	.29	13250	494.0
		80	28.5	6610	98.8
		86	28	4410	61.8
		95	27	2850	39.6
		103	26	2210	30.1
		108	25	1800	26.2
	80	82	28.5	11330	493.0
		92	28	6960	82.0
		99	27	3520	52.0
		106	26	2560	38.1
		108	25	2070	35.5

In London *Engineering* of Jan. 9, 1914, p. 38, is given a diagram "due to J. M. Newton," showing values of m for various vacuums and initial temperatures of cooling water. The effect of varying amounts of air leakage is, however, not shown as in Fig. 2 herewith. In most cases m would be easier to measure than the average temperature of the mixture in the condenser and could be used as an indication of whether the dry- and wet-air pumps were each doing its proper share of the work.

To find the vacuum which will make the net work a minimum, we must assume the water rate of the turbine and the efficiency of the air pump. By net work is meant the work developed per pound of steam by the turbine, minus the air-pump work per pound of steam needed to produce the vacuum. We have assumed the turbine to be acting under 150 lb. gage pressure, dry steam, without superheat, and have taken air-pump efficiencies of 50, 65 and 80 per cent. Stodola assumed for the air pump an efficiency of 50 per cent. and took for the turbine an admission pressure of 142 lb. with an initial temperature of 572 deg. F., or 218 deg. superheat. Using, as he did, an indicated efficiency of 65 per cent. and a mechanical efficiency of 90, this would be equivalent to assuming that the water rate varied with the vacuum, as shown in Table II, which also gives the water rates herewith employed.

TABLE II

Vacuum in Inches	Water Rate Used by Stodola, Lb. per B.hp. per Hour	Value in Ft.-Lb. of 1 Lb. of Steam	Water Rate Used in Fig. 2, Lb. per B.hp. per Hour	Value in Ft.-Lb. of 1 Lb. of Steam
25	14.0	63,300	18.5	47,900
26	13.5	65,600	17.6	50,300
27	12.8	69,100	16.7	53,200
28	12.1	73,100	15.9	55,700
28.5	11.5	77,100	15.4	57,600
29	11.0	80,500	14.7	60,300

The writer has assumed that the turbine was designed for a vacuum of 27 in. and that, consequently, the efficiency decreases slightly from the maximum of 50.0 per cent. when the vacuum is either higher or lower than the normal. The efficiencies are somewhat lower than the constant value of 58.5 per cent. taken by Stodola

and apply more especially to small-sized turbines, while his value would be more suitable for the larger sizes.

Stodola assumed various rates of air leakage up to about 150 cu.ft. per min. for a 1000-kw. turbine, and found that with his assumed efficiency the most economical vacuum was always over 29 inches, increasing with a decrease in the amount of air in the condenser. He used a temperature of cooling water of 50 deg. F. and a value of $m = 50$. Table III shows the results obtained with m having a variable value as in Table I. Where the most economical vacuum is different for two different efficiencies of the air pump, both vacuums are

TABLE III

Leakage of Air in per Cent. of Weight of Steam	Temperature of Cooling Water, Deg. F.	Vacuum, Inches of Mercury	Net work of Turbine in Ft.-Lb. per Pound of Steam, with Air Pump Efficiency in per Cent. Equal to 50	65	80	50 (Stodola)
0.00	32	29	58,880	59,210	59,410	79,080
	50	29	57,940	58,480	58,820	78,140
	60	29	56,500	57,380	57,930	76,700
	70	28.5	53,700	54,600	55,160	73,200
	80	28	52,220	53,020	53,520	69,620
0.31	32	29	56,000	56,990	57,610	76,200
	50	29	53,700	55,220	56,170	73,900
	60	29	(50,660)	(52,870)	54,270	(70,860)
	60	28.5	52,120	53,380	(54,170)	71,620
	70	28.5	(49,580)	(51,430)	52,580	69,080
	70	28	50,360	51,590	(52,360)	(67,760)
	80	28	(47,840)	(49,650)	50,790	65,240
	80	27	48,980	50,050	(50,560)	(64,880)
0.62	32	29	54,280	55,670	56,530	74,480
	50	29	(51,100)	53,220	54,550	71,300
	50	28.5	51,640	(53,020)	(53,870)	(71,140)
	60	28.5	50,200	51,910	52,490	69,700
	70	28.5	(46,720)	(49,230)	(50,780)	66,220
	70	28	(48,560)	50,210	51,230	(65,960)
	70	27	48,600	(49,660)	(50,320)	(64,500)
	80	27	47,420	48,750	49,590	63,320
0.93	32	29	52,620	54,390	55,500	72,820
	50	29	(48,780)	(51,450)	53,100	(68,980)
	50	28.5	50,140	51,860	(52,940)	69,640
	60	28.5	(48,160)	(50,330)	51,700	67,660
	60	28	48,800	50,390	(51,380)	(66,200)
	70	28	(46,880)	48,920	50,190	64,280
	70	27	47,500	(48,820)	(49,640)	(63,400)
	80	27	46,160	47,780	48,780	62,060

Note—Where the most economical vacuum is different for two different efficiencies of the air pump, both vacuums are given, the values of the net work, which are not maximum, being inclosed in parentheses.

included in the table, the values of the net work, which are not maximum, being inclosed in parentheses. The same results are shown graphically in Fig. 2 for air-pump efficiency of 65 per cent. For each of the four amounts of air leakage, from zero to 0.93 per cent., there are five curves for the five different temperatures of cooling water assumed. It will be seen that the most economical vacuum is by no means always as high as 29 in.

In the last column of Table III is given the net work of a turbine, assuming the same efficiency for the air pump and the turbine as taken by Stodola, but taking values of m from Table I. A comparison of columns 4 and 7, Table III, shows that a higher turbine efficiency makes but little difference in the most advantageous vacuum, so long as the efficiency of the air pump is the same. In no case, however, would the most advantageous vacuum, for given conditions, be as high as here calculated, because no account has been taken of the cost of bringing cooling water to the condenser, which increases with m and hence with the vacuum.

Before Applying a Hydrostatic Test to any boiler, gage lines should be located and gages fixed in order to detect any tendency to bulge or become distorted when under pressure and show whether the parts return to their original contour or not. Otherwise, the test will be of little value or may even do serious damage, leading to failure later. Such tests should be made by skilled and experienced men, never by thoughtless amateurs.

JUST FOR FUN

A Painstaking Job, but in the Wrong Place

A green man taking down some circuits cut the wires and instead of carefully separating the ends on the live side he spliced the two lines together, then soldered and taped the joint. That evening when it was time to turn the current on that line, things were lively for a while. —*Harry D. Everett, Washington, D. C.*

What Is Electricity?

I'm going to slip you one by Ike Hedges. He says: "In the fall of 1913 I dropped off at Bologna, Italy, on my way from Venice to Florence. Consulting my Baedeker, I learned that the famous thing about Bologna was its ancient university, and that three great men in the electrical world had at one time attended this famous institution of learning—Galvani, Volta and Marconi. The conclusion, therefore, is inevitable, that whatever electricity may be, its basic principal is sausage." (Well, it might be "wurst.")—*Terrell Croft,* St. Louis, Mo.

A Lively Time

The second item in the "Just for Fun" column, Mar. 9 issue, reminded me of a similar incident.

The electrical system was being changed from a two- to a three-wire system, and a temporary wooden switchboard was being built above and to one side of the one in use. The carpenter above was nobly trying to balance a long piece of "two by four" that was slowly but surely getting away from him. He yelled for help. His helper below, a large steel square in his hand, realized the need of quick action. He looked around for a place to lay the square, and one of the main switches happened to be the place. The action was quick. No one was seriously hurt, though there was a most confusing mixup of men, fire, noise and the "two by four." The helper, who had vanished as though swallowed by the earth, "showed up" four days later.—*C. H. Dalrymple, New York.*

"A Pound's a Pound the World Around"

I read your "Just for Fun" column with considerable pleasure and was particularly interested in an article in the Feb. 23 issue, page 264, in which the member of the school board made such wise remarks about the flow of steam. It reminded me of a somewhat similar experience while superintendent of a municipal plant in a mining town in Illinois. After a new boiler had been completely installed the Village Board came down to the plant to see it put under pressure. Among the various suggestions for raising the necessary hydrostatic pressure, one was to fill it full, close all valves and build a light fire so that the expansion of the water would give the desired pressure. The idea was all right, only I explained to them that the safety valve was set for only 150 lb. and would blow at that pressure, and would have to have a gag on for the test and that I could pump up the pressure in a much less time. One of the members, the owner and operator of a steam-operated brick yard, said that it ought not to lift at 150 lb. water pressure as 150 lb. steam pressure was equal to 250 lb. water pressure and the valve was set for steam pressure.—*W. P. Martin, Connelton, Ind.*

First Uniflow Plant on Pacific Coast

SYNOPSIS—The requirements demanded generating sets capable of providing elevator and lighting service without flickering lights and also to take care of a large roof sign which is thrown on and off every thirty seconds. The engines and boilers are in a common room; there is no dust, as fuel oil is burned in the boiler furnaces. The uniflow engines on test with less than 150 lb. steam pressure showed an average steam consumption from one-fourth to full load of less than 20 lb. per indicated horsepower-hour.

The power-plant equipment of the New Hotel Rosslyn, Los Angeles, Calif., presents the solution of an engineering problem which will be of interest to engineers.

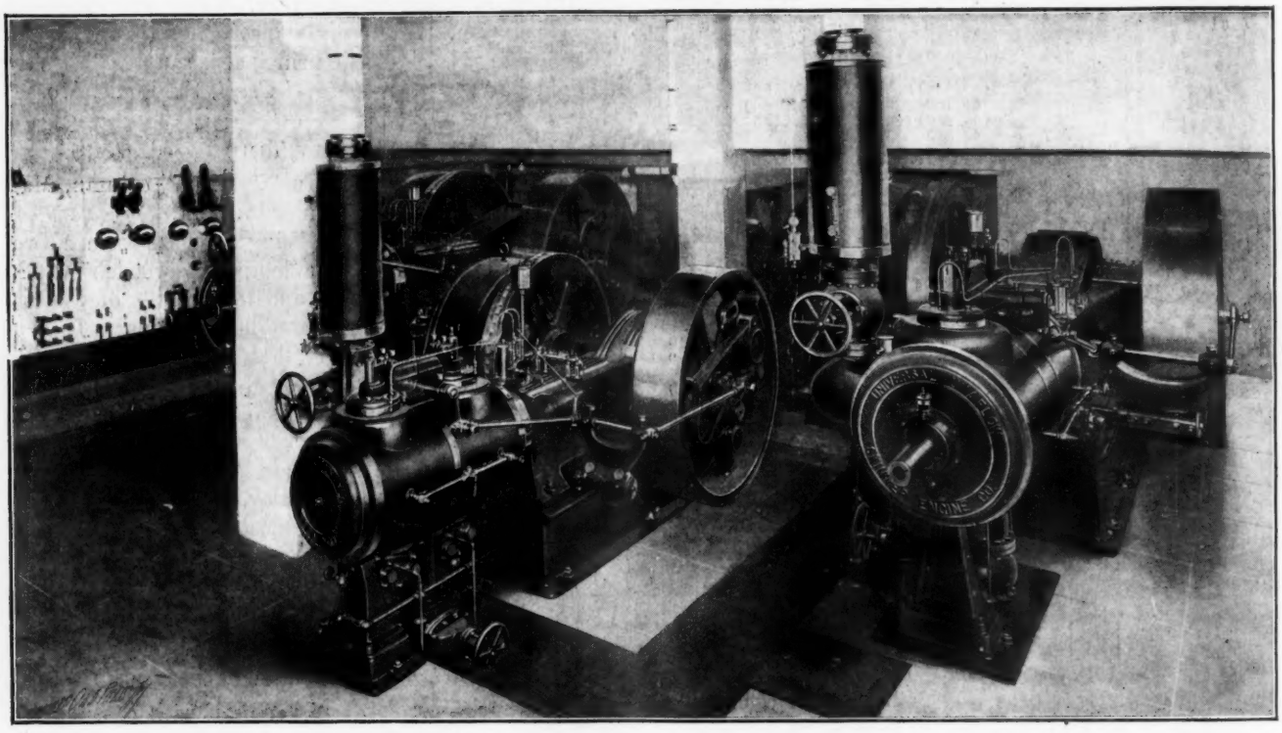


FIG. 1. ONE 100-KW. AND TWO 200-KW. "UNIVERSAL UNAFLOW" ENGINES DIRECTLY CONNECTED TO DIRECT-CURRENT GENERATORS

This hotel is 12 stories in height, with basement and sub-basement, and contains, with an annex, 850 rooms. There are four passenger and three service elevators, of the high-speed traction type. It was required to provide generating capacity that would take care of the elevators and lighting load from the same circuit without causing the lights to flicker. Clusters of tungsten lamps against light-colored ceilings and walls were to be used, which would have a tendency to magnify the least flickering of the lights.

In addition to the fluctuating elevator load, provision also had to be made to take care of a large roof sign which was to be thrown entirely off and on at intervals of 30 sec. Besides being able to cope successfully with the fluctuating nature of the load, the plant had to be an economical one, because electricity in Los Angeles is sold on a sliding scale, making it possible for large users to purchase it at a rate of approximately $0.0135 per kw.-hr.

The building was originally laid out with the intention of purchasing current, and therefore the space that could be allotted to the power plant was very small. This difficulty was largely overcome by the fact that oil-burning boilers were installed. The space between the nearest engine and the boilers would hardly permit the slicing of fires if coal were used for fuel.

E. L. Ellingwood, consulting engineer, of Los Angeles, was employed by the architects, Messrs. Parkinson & Bergstrom, to make the plans for the power plant and heating system.

Three "Universal Unaflow" engines were selected, two being of 200-kw. capacity at 200 r.p.m., and the third of 100-kw. capacity at 225 r.p.m. (Fig. 1). Direct-current three-wire generators were selected. The boiler plant consists of three 196-hp. water-tube boilers (Fig. 2), equipped for the burning of fuel-oil. The steam pressure is 150 lb. at the boilers. Saturated steam is employed. The engines on a test at somewhat lower steam pressure than 150 lb. showed an average steam consumption from one-fourth to full load of less than 20 lb. per i.hp.-hr. The plant is a good investment for the owners of the hotel, as the total cost of operation, including interest, depreciation and a charge of $0.50 per sq.ft. per year for floor space, is $0.0116 per kw.-hr.

The total connected load is about 760 kw., of which 260 kw. is motor load; and although this is of a decidedly fluctuating nature, owing to the traction elevators and the intermittent electric sign, no flickering of the lights in any part of the building can be noticed.

The engines and boilers will attract the attention of Eastern engineers, owing to the fact that they are placed in one room, which is finished in white. This arrangement is possible and practicable on account of burning fuel-oil under the boilers. The engine and boiler room is well lighted by 200-watt tungsten lamps suspended close to the ceiling. Fig. 3 is a view of the switchboard, which is also shown in part in Figs. 1 and 2.

In addition to the power plant, there is a refrigerating system calculated to provide circulating water in every room at a temperature of 37 deg. F., the test conditions being rigid, as only 8 oz. of water was allowed to be drawn from the faucets in order to arrive at the test temperature of the water. The refrigerating equipment consists of one 18-ton horizontal ammonia compressor, direct-driven by a Corliss engine at 66 r.p.m. The plant manufactures 1200 lb. of ice every 24 hours, and furnishes refrigeration for all cold boxes in the storage department of the hotel, the bar, the cigar and flower shops.

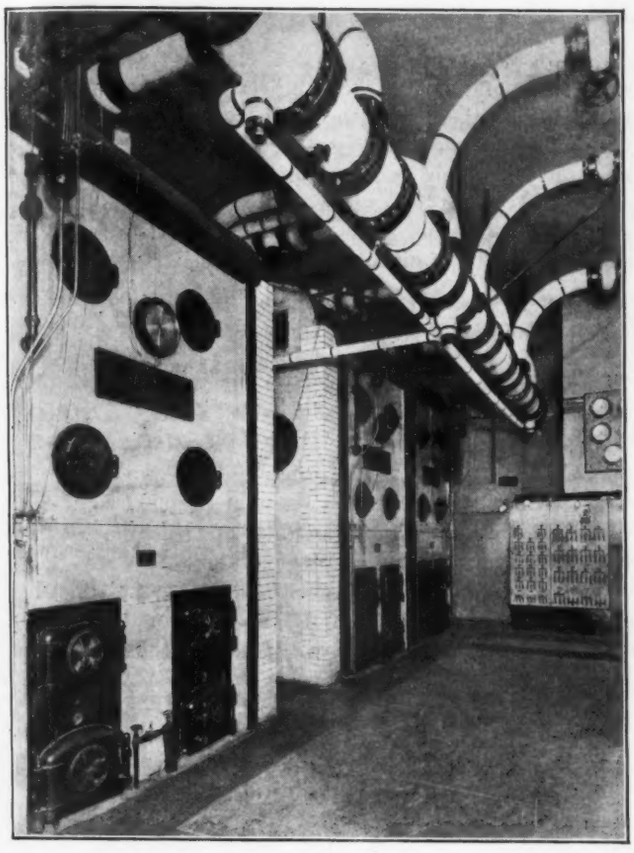


FIG. 2. THREE 196-HP. WATER-TUBE BOILERS; FUEL OIL IS USED IN THE FURNACES

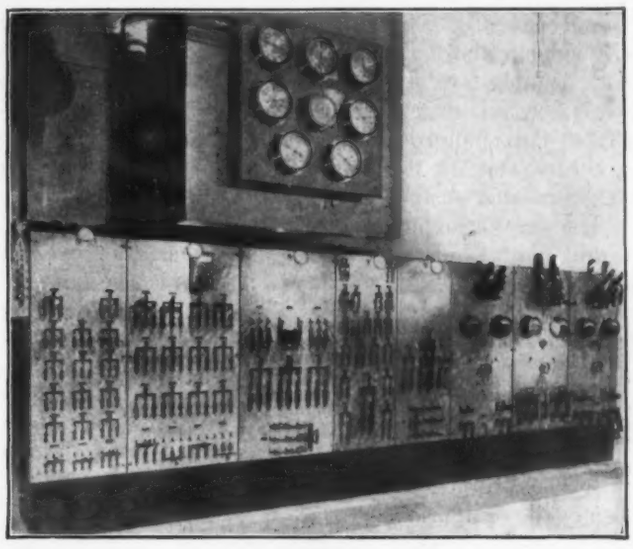


FIG. 3. SWITCHBOARD FOR GENERATOR AND CIRCUIT CONTROL

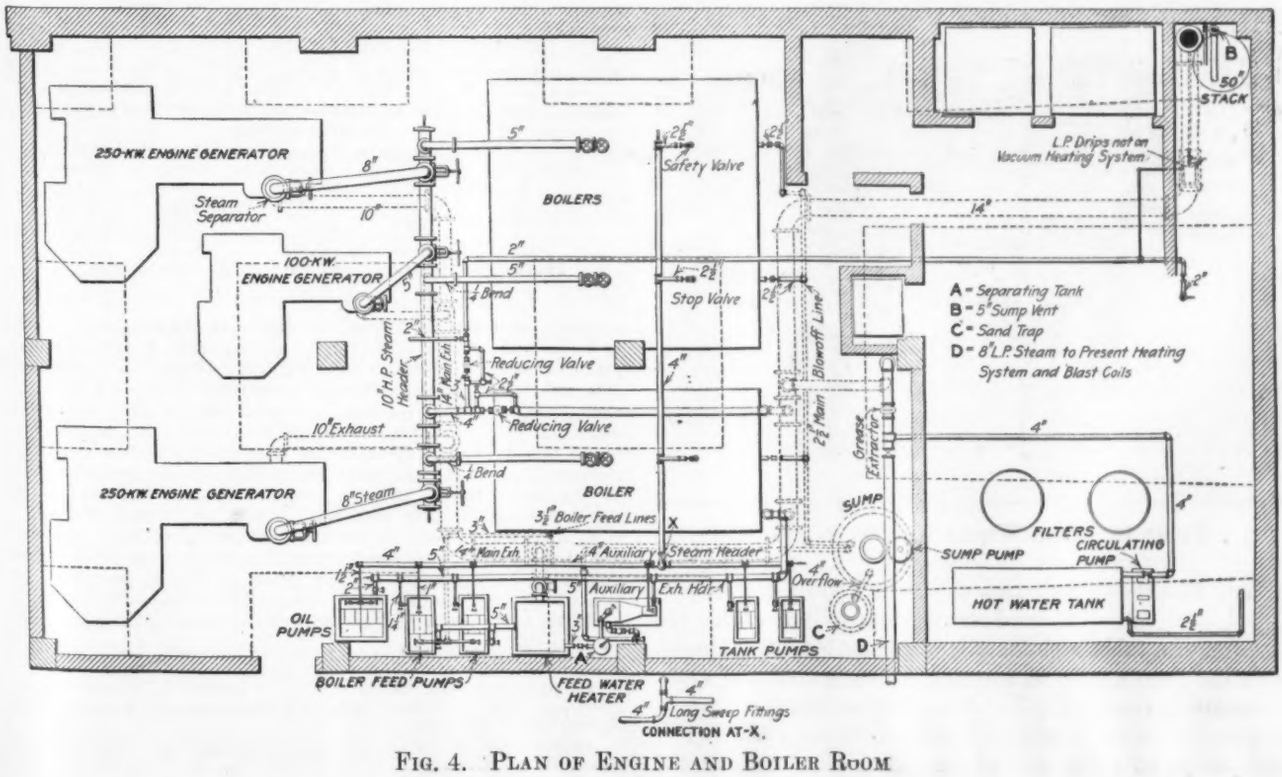


FIG. 4. PLAN OF ENGINE AND BOILER ROOM

PRINCIPAL EQUIPMENT OF THE HOTEL ROSSLYN, LOS ANGELES

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Engines	Universal Unaflow	200-kw.	Main units	200 r.p.m., 150 lb. steam, saturated	Skinner Engine Co.
1	Engine	Universal Unaflow	100-kw.	Main unit	225 r.p.m., 150 lb. steam, saturated	Skinner Engine Co.
2	Generators	Direct-current	200-kw.	Main units	200 r.p.m., three-wire system	Crocker-Wheeler Co.
1	Generator	Direct-current	100-kw.	Main unit	225 r.p.m., three-wire system	Crocker-Wheeler Co.
3	Boilers	Water-tube	196-hp.	Steam generators	150 lb. steam, saturated	Badenhausen Boiler Co.
1	Compressor	Ammonia	18-ton	Refrigeration system	Engine-driven, 66 r.p.m., 1200 lb. ice per 24 hr.	Vulcan Iron Works.
1	Engine	Corliss		Driving ammonia compressor	150 lb. steam, 66 r.p.m.	Murray Iron Works
1	Pump	Tank		Water to storage tank		Henry R. Worthington
2	Heaters	Tank		Hot water for house	Thermostatically controlled	Frank L. Patterson
	Dunham heating system for the building, using exhaust steam,					C. A. Dunham Co.
	Ventilating system, exhaust fans,					B. F. Sturtevant Co.

Water for lavatory, laundry and kitchen purposes is heated in a battery of two combination tank heaters thermostatically controlled, the water being circulated throughout the building by centrifugal pumps. The water-supply for the building is from roof storage tanks of 34,000 gal. capacity, automatically filled by a steam-driven tank pump located in the sub-basement.

Steam heat for the building is by means of a system using exhaust steam exclusively.

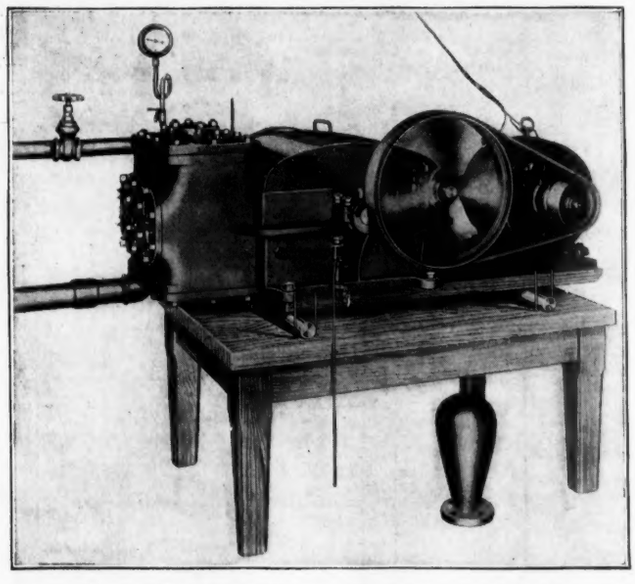
The ventilation in the service department, lobby and dining room and the exhaust ventilation from all the toilets, lavatory and bath systems is provided by fans.

The water for refrigerator, laundry and boiler-room use is treated by the lime and soda process, as Los Angeles city water runs from 22 to 26 deg. German hardness.

The compact nature of this plant, as shown by the plan, Fig. 4, was necessary on account of the limited floor space turned over to the engineer for the installation of the equipment.

Luitwieler Double-Acting Triplex Pump

At the factory of the Luitwieler Pumping Engine Co., Rochester, N. Y., may be seen a double-acting triplex pump operating at speeds from 100 to 300 r.p.m. The



PUMP RUNNING WHILE RESTING ON ROLLS

illustration shows the pump operating upon a pair of polished steel rollers 2 in. diameter, the rollers resting on the top of a table. There is no air chamber on the pump and the gage needle stands still, showing that the water pressure is constant. To show that no vibration exists, a wire nail 5 in. long stands motionless upon the top of the pump; on either side of the rollers other nails of the same size stand on end touching them. If there was any movement of the rollers the nails would topple over, but the pump operates at these high speeds day after day with the same nails standing immovable.

The Luitwieler pump was described on page 53 of the July 8, 1913, issue. All the driving mechanism is inclosed in a bath of oil and needs practically no attention.

Dimensions, Weights and Costs of Steam Turbines*

BY A. A. POTTER† AND S. L. SIMMERING‡

Tables 1 and 2 were compiled from data supplied by manufacturers and should prove of value in connection with preliminary estimates. The dimensions, weights and cost data are for condensing units and include the turbines and alternating-current generators.

The values in Table 2 were plotted and the following equations were deduced, giving the cost in dollars (C) of the turbine and generator, in terms of the capacity in kilowatts.

Impulse types $C = 5040 + 9.2\,kw.$ *(Dollars)*

Reaction types $C = 7400 + 8.26\,kw.$ *(Dollars)*

TABLE 1—DIMENSIONS AND WEIGHTS OF CONDENSING STEAM TURBINES, INCLUDING GENERATORS

Size	Impulse Type						Reaction Type					
	Lgth.		Width		Hght.	Weight	Lgth.		Width		Hght.	Weight
Kw.	ft.	in.	ft.	in.	ft. in.	Lb.	ft.	in.	ft.	in.	ft. in.	Lb.
300	15	10	5	0	5 4	18,500	16	0	6	0	.. ..	24,000
300							20	0	6	0	5 10	37,900
500							18	0	6	0	.. ..	30,000
500	16	1	7	3	6 6	34,800	20	9	6	0	5 10	42,600
1000							24	0	6	0	.. ..	60,000
1000	16	0	6	10	7 6	45,000	18	4	6	9	6 8	52,250
2000	20	6	9	0	7 9	75,000	25	6	9	4	7 9	105,000
2000							26	0	7	0	.. ..	90,000
5000	25	1	10	7	9 8	175,000	34	9	11	5	9 1	236,000
5000							34	0	8	0	.. ..	190,000
10000	32	5	12	9	12 0	310,000	45	0	10	0	.. ..	320,000

TABLE 2—COST OF CONDENSING STEAM TURBINES AND GENERATORS

Size, Kw.	Impulse Type		Reaction Type	
	R.p.m.	Cost	R.p.m.	Cost
300	3600	$8,000	3600	$7,650
500	3600	9,600	3600	9,550
1000	3600	14,000	3600	13,750
2000	3600	23,000	3600	22,800
5000	1800	55,000	3600	48,700
10000	1800	95,000	1800	90,000

Duty of a Pump—There are different definitions for what is termed the "duty of a pump," each giving a different estimate or value. The duty is sometimes defined as the weight (lb.) of water raised through a vertical height of 1 ft. for each 100 lb. of coal burned; or, more simply, the theoretical work (ft.-lb.) performed per hundredweight of coal burned under the boiler. It is observed that this definition is faulty, because it combines furnace and boiler efficiencies with that of the pump itself, besides estimating only the theoretical work performed, thus eliminating friction, which is often a most important factor. The true definition of duty in pumping is the actual work performed in a given time (ft.-lb.), per million B.t.u. delivered to the pump in the same time. Or, less frequently, the duty is estimated in foot-pounds of work performed per thousand pounds of dry saturated steam consumed.—"Coal Age."

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‡Instructor in steam and gas engineering, Kansas State Agricultural College.

Editorials

Accepting the Inevitable

Always present in every community are the "kill-joys," who see nothing but ruin ahead if this or that is done. Yet somehow, we always have lived through the administrations that were prophesied to bring the country to disaster and, strangely enough, we are getting better all the time. It seems as though progress has a certain momentum that will carry it on in spite of all obstacles, including the well-meaning people who cannot anticipate success except by time-worn methods.

In this connection a recent utterance of George Otis Smith, director of the United States Geological Survey, in an address at the University of Illinois, is to the point:

> The trouble with too many of the business men of the day, and especially with those who come to Washington to oppose new legislation, is their nearsightedness. They cannot see country-wide public opinion and do not appreciate the obvious fact that the financial centers are not also the centers of national thought. The result of this, as I expressed it in conversation last winter with a New York gentleman who was largely interested in water-power development, is that the business interests oppose something at one Congress which two years later they would accept; but the next Congress is already considering a more advanced legislative proposition. We are all more or less progressive, I told him, but the opposition has been just one lap behind.
>
> The bright light of publicity is coming to shine more and more upon the inner workings of all private business which has anything of the public-service character. Only about three years ago, at a conference on water-power policy, I heard the representative of the banking houses interested in the hydro-electric business tell the Secretary of the Interior, with considerable warmth of spirit, that one thing the men who make possible the development of our country by their contribution of capital would not stand for was any legal requirement of inspection of their accounts by the Government. A corporation has its rights, they contended, just the same as a private man in business. Last year in the same room, when the utilization of a large power site owned by the Government was being discussed, I heard those asking for the permit dismiss the question of Federal inspection of their books with the remark, "That need not be discussed, our books will of course be always open to any authorized representative of the Government." The ultimatums pronounced by the ambassadors from Wall Street, State Street and West Adams Street are short-lived in the present atmosphere of popular interest in these business questions.

To go back to our first thought that progress is going to "get there" "nevertheless and notwithstanding," the situation is much like that of a trolley car or automobile trying to cross a busy street. People and traffic will continue to hold up the car by passing in front of it like so many obstructionists until the Law, personified in the traffic "cop," gives the car the sign to come ahead. Then the pedestrians have to look out for themselves and let the car pass. The car loses a little time, and so do the people, but eventually all get on and no harm is done. So it will be with the questions that Congress or State Legislatures are called upon to decide. Ultimately, they will be settled the right way, and the sooner opposition is withdrawn the sooner conditions will adjust themselves to everyone's satisfaction. Right is the good of the majority, and private interests mindful only of their profit will do well to accept the inevitable without expensive delay. It is futile to hinder progress.

Principles versus Details

To most engineers the study of principles is less interesting than apparatus embodying them—details of valves, piping, generators, etc., grip the attention far more readily than what look to be theoretical abstractions. This is only natural, for most people think in concrete terms; the specific appeals to the intellect of the great majority more than does the general; and iron and steel, water and coal, copper wire and insulation, belong so positively to the realm of things seen and handled that many minds never get much beyond these visual conceptions.

Mastery of details is essential to engineering success, but advancement to professional standing calls for recognition of principles. We hear too much about the "man behind the throttle," as though mere manipulation were the index of the engineer's ability. Striking phrases like these are useful in their place, but are largely figures of speech, and their symbolism should not be taken too literally. Without brains to guide the hand on the throttle, to appreciate what goes on on each side of the valve disk, and to anticipate in imagination the results of various steps in plant operation, we should have short shrift from the business world. Power to think in terms of principles—to theorize—is the means to rise out of mediocrity into distinction. Acquiring it means drudgery and plenty of it, but it also means advancement on a solid foundation, with a broad comprehension of the significance of details which mere cleverness in mastering the latter can never supply.

Appreciation of the laws of steam, hydraulics and electricity, knowledge of the strength of materials and comprehension of the chemical and physical principles bearing upon combustion of fuel, the production of steam or producer gas, a broad grasp of the elements of lubrication and of the essentials of heat phenomena, will serve the engineer well in time of need. It goes without saying that to understand the *why* of his work as well as the *how*, these important matters cannot be neglected. Even after a man has gone through a rigorous course in mechanical engineering and spent several years in practice within the plant, it will pay him to occasionally review the fundamentals of his profession. Defects in early training can thus be remedied, and most of us have weak spots in our technical armor.

In these days of distributed information, with interesting bulletins and catalogs coming from all quarters of the land at the price of a postal card, it is easy to form the habit of following *applications* of principles to the exclusion of studying fundamentals themselves. It is amazing how helpful it is to review the elements of steam engineering, for example. Much of the matter can be gone through rapidly, but such a review strengthens the grasp of the reader on the great essentials of his occupation and thereby better fits him to grapple with fresh problems in his own field. Judgment in the application of these principles is developed as the seasoned operating man refreshes his mind again and again with the foundations of his profession; the true significance of detailed prac-

tice becomes more apparent, and the ambitious worker thus prepares himself for greater responsibilities and more accurate decisions.

For Industrial Betterment

General industrial activity makes for our prosperity as a nation. If the shops and mills are inactive, this depression affects all seriously, including the operating engineer, whose function it is to keep the power wheels in motion.

As the time approaches for the convening of the two largest organizations of operating engineers in America, it is to be hoped that, with their avowed objects for general good and their tremendous possibilities for advancement in knowledge and prosperity, they will give some heed to the upset and unrest of business conditions and find means to coöperate with the commercial interests in seeking a remedy.

While the war has had its influence, helping some business although hurting most, it would not account for so much idleness when the crops are big and their prices high, when our financial condition is strong, and when labor and capital were never so willing to coöperate. Conservatism, or in other words, lack of confidence seems to be the trouble. It is a time when the cautious are very slow about taking even the slightest risks.

One contributing cause of this uncertainty and fear is that honest business interests are in doubt as to just what they can do lawfully in the face of so much new and untried legislation. They do not know how to conduct their affairs in accordance with laws that are apparently interpreted one way today and another tomorrow, consequently, some have ceased to do business; their plants are closed and their employees idle. A wild "tooting on the horn of plenty" is merely noise, not a remedy, nor is the "popular" legislation of those politicians who are actuated by narrow and sordid self-interest. Our industrial prosperity furnishes the sinews of our citizenship, and our membership in the engineering organizations gives us ample authority to work in every legitimate way for those interests. No one influence has been so powerful as that of the engineers in placing wise boiler laws on the statute books, in safeguarding lives and property against criminal operation of power plants, and in framing the license laws governing our fellows. Is it not time, then, that we voice our protest against unwise legislation, investigation and control wherever and whenever it affects us? Our Government is a government of the people; we have a part in it. It is sovereign in its power to so adjust and fix conditions that we, the people, may enjoy the honest activity in our vocations, which is our right.

We need a much wider publicity for each proposed legislative measure, whether it affects our field directly or only indirectly. Therefore, we believe that every organization whose purpose it is to uplift and promote the interests of its members should have timely knowledge of proposed laws, and when affected by them should have the chance to express its approval or disapproval.

Cutting "Lumber" out of Reports

Ability to write a clear-cut, straightforward report unencumbered with superfluous material is worth cultivating. Many an operating engineer would dread the task of preparing a report, for instance, on the desirability of replacing a vertical cross-compound engine with a turbine. Usually, it is not so much the engineering problem as the literary end of the work that looks burdensome. Sound figuring is demanded first of all, but if the correct conclusion is reached there should be little further anxiety.

The form of report desired will depend on the employer, but most busy men want a terse, clear statement of conclusions, to which they can turn at once. While it is proper to include it, the reasoning upon which the recommendation is based is secondary. It is very easy to encumber a report with useless description and discussion. Such matter has appropriately been called "lumber" by an engineer experienced in scanning written matter, and good judgment in eliminating it is profitable.

In the case mentioned, a well-considered report might follow a statement of the problem in hand, with the conclusion that it will pay to make the change and that the annual saving would be about a certain sum. The rest of the report may then be an appendix in support of the contention.

The argumentative part of the report might include a statement of the capacity and service of the equipment to be displaced and the present operating costs and fixed charges, taking care to mention all assumed factors, like the percentage of interest, insurance and depreciation allowed. Test data on which existing cost figures are based may be summarized, and the limitations of the equipment in point of space, in meeting a growing load, etc., discussed. Then should follow an estimate of the cost of substituting a unit of increased capacity, with the fixed charges and estimated operating cost, with the statement of authority for steam consumptions assumed, guarantees offered, etc., and a final tabulation of yearly cost of a stated service, with a checking of the total against the present total if desired, or a comparison of unit expenses at the busbar. Modifications in auxiliary plant should also be covered in their proper places.

In presenting such information literary style will largely take care of itself if the report is logical and intelligible at all points. If it lacks clearness, if it cannot be checked by another competent engineer without consulting the writer, if it includes long and rambling accounts of possible equipment combinations without predicting definite results, and if it fails to concentrate similar information effectively, the force of the engineer's recommendations may be greatly weakened.

It is the technical judgment of the engineer that the employer values, and the selections of factors, the arithmetical processes and methods adopted concern him less. To an extent, the less language a report contains, the more helpful it will be to the employer's decision.

In January, 1909, a half dozen years ago, President Roosevelt wrote:

> The people of the country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known in our experience. A single generation will see the exhaustion of our natural resources of oil and gas and such a rise in the price of coal as will make the price of electrically transmitted water power a controlling factor in transportation, in manufacturing and in household lighting and heating.

And it still threatens; witness the defeat by its proponents of administrative water-power legislation in the late Congress.

Correspondence

Theoretical Efficiency of Heat Engines

The article by Mr. Heck in the issue of Apr. 20, concerning "Theoretical Efficiency of Heat Engines," contains a reference to an earlier statement by myself in POWER of June 9, 1914. In general, the detailed analysis of the problem by Mr. Heck is entitled to unqualified approval, were it not for the risk that some of the inferences might contaminate the future bibliography on the efficiency of heat engines because of an incomplete quotation of my remarks. The omission of the closing sentence of the paragraph to which reference is made is herewith supplied: "This (53.3%) cannot be approached on account of practical limitations." This would seem to be sufficient reassurance that I am not disposed to attach any value to the perfect gas formula as an indication of the attainable performance of heat engines.

In stating the "perfect gas" formula as a limit, I am not only safe, but also following the practice of authorities in thermodynamics sufficiently to remove the second law, for which the formula is simply an algebraic expression, from the realm of discussion. There may be other and lower limits for particular operations, but they do not serve as a means of disproving the validity of the Carnot cycle as one of limiting high efficiency. Nor do they establish "ideal steam cycles," as there are alternatives to the Rankine cycle which surpass it in efficiency.

There is a process, as indicated by Boulvin in 1897 and reproduced in the translation by Bryan Donkin of "The Entropy Diagram and Its Applications," which produces a working cycle for any fluid, including steam, attended

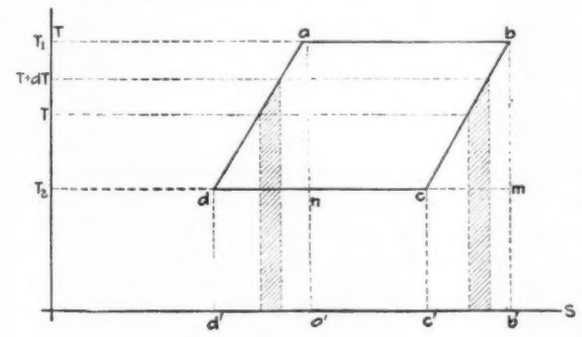


FIG. 1

by a higher efficiency than that of the Rankine cycle. In fact, carried to the limit it would have the same efficiency as the Carnot cycle, theoretically. In order to avoid a further misinterpretation I will now insist that this cycle, like that of the Carnot, cannot be completely realized on account of practical limitations. Nevertheless, an incomplete process can be devised and has actually been applied with noticeable improvements over the Rankine cycle.

Referring to the entropy diagram Fig. 1 (Fig. 7, Boulvin-Donkin) as reproduced without reference to a scale, *ab* and *cd* are isothermal lines, *bc* is an arbitrary path of the working fluid, *ad* reproduces and is exactly parallel to *bc*. The heat converted into work is proportional to the area *abcd*, or its equivalent as a rectangle *abmn*. The heat rejected in the cycle consists of two parts represented by the areas *cdd'c'* and *bcc'b'*. The latter is exactly equal to the heat required to carry out the process *da*. If, in the course of rejection of heat along *bc* and the drop of temperature from $T + dT$ to T a means is provided for storage of this heat and the maintenance of such tem-

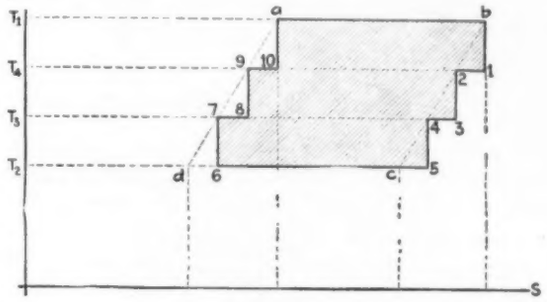


FIG. 2

peratures, it may with adequate equipment be applied to the heating of the fluid at a certain part of the path *da* without the intervention of a source of heat. The heat stored is represented by *bcc'b'* and is returned to the fluid as the area *d'daa'*. The efficiency of the cycle is the ratio

$$E = \frac{abcd}{d'dabcc'} = \frac{abmn}{a'abb'}$$

Since an infinite number of heat reservoirs cannot be applied, the theoretical limits of the cycle cannot be realized. But a modified adaptation of a limited number of regenerators or heat reservoirs, each operating in a particular temperature range, can be applied, with the result that the limit of thermal efficiency may be considerably higher than that of the simple Rankine cycle. The latter is not, therefore, an "ideal steam cycle."

Referring to Fig. 2 (Fig. 8, Boulvin-Donkin); replace the continuous line *bc* by the broken line *b 1 2 3 4 5 c* and the line *da* by a similar broken line *d 6 7 8 9 10 a* and we have a cycle having the same efficiency as the Carnot and which may be designated as a system for "regenerative" feed heating. The essential features of this cycle consist of abstraction of heat from the steam during its transit through a multiple-expansion engine and a successive higher heating of the feed water in a number of closed heaters, transferring their heat at different temperatures between T_1 and T_2. For example, the heat absorbed during the operation *1 2 4 3* and between the temperatures T_3 and T_4 is transferred to the feed water after it has been heated to the temperature T_3 and through the part *7 8 9 10* of the cycle. A perfect storage and restorage of heat in this manner is impossible, but a move in that direction, with highly gratifying results thermodynamically, has been made in the case of the multiple-expansion pumping engine for the Wildwood station of the City of Pittsburgh and devised by B. V. Nordberg.

A simple addition of but two elements of this regenerative feed-heating process is capable of such improvement of the Rankine cycle and of the illustrative example proposed by Mr. Heck that his figure of 0.335 for thermodynamic efficiency is too low and is not therefore an "ideal steam cycle." Moreover, the limitation of saturated-steam temperatures to 380 deg. F. is one which engineers need not hesitate to transgress, as pressures of 700 lb. per sq.in. and more on certain types of small boilers have been applied without calamity. The rapid improvements in the construction of steam turbines reveal that their designers are possessed of sufficient courage to venture on even to the utilization of a modified regenerative feed heating to further improve the cycle of operations, when, if ever, we may hope for a near approach to the realization of an efficiency indicated by the "perfect gas formula."

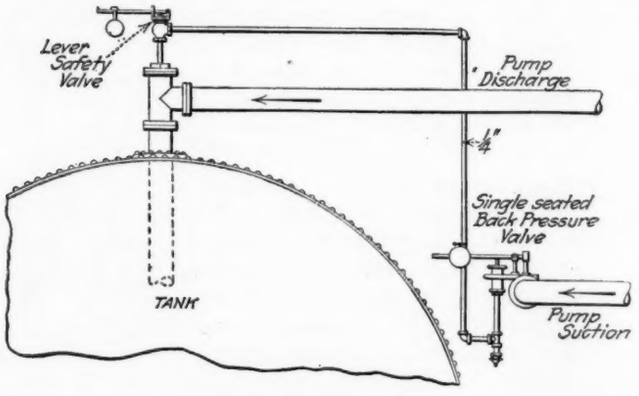
F. G. GASCHE.

South Chicago, Ill.

Pump Regulator

The owner of a greenhouse wished to install a gas-engine-driven pump for watering. To provide for future demands for more water, and to avoid excessive pressure if the demand should decrease while the pump was being operated, it was necessary to provide for controlling the flow by means of the variation in pressure.

An ordinary single-seated back-pressure valve with outside dashpot was purchased and remodeled, the dashpot being placed on the opposite side so that pressure



PIPING OF REGULATOR

under the piston tended to close the valve. A common lever safety valve was connected to the discharge pipe near the tank, with its discharge leading through a ¼-in. pipe to the bottom of the dashpot. A drip-cock was placed in this line for relieving the pressure, but it was not necessary.

In operation, when the pressure exceeds that for which the safety valve is set, the valve opens and admits water under pressure to the dashpot. This raises the lever and weight and closes the valve. The pump then runs idle until the pressure in the tank falls and the safety valve closes. The slight leak around the stem of the safety valve relieves the pressure and the suction valve opens, due to the weight.

The pipe leading to the safety valve is extended nearly to the bottom of the tank to avoid loss of air, which would leak much faster than water if the seat of the valve should become worn.

To prevent the pump from becoming air-bound when running idle, it was necessary to drill and tap the water passages at the ends of the cylinder and connect check valves. The discharge from these was run through a globe valve to the hopper of the engine, and the overflow led to the sewer. This gives the engine cooling water in sufficient quantities when the pump is working, and the water in the hopper is sufficient for cooling when the pump is running idle.

The device will operate to open or close the suction with a variation of 5 to 6 lb.

A. H. BULLARD.

Syracuse, N. Y.

Preventing Water Hammer in Blowoff Pipes

Regarding the suggestion of a safety valve on the blow-off line by Mr. Fenwick in the issue of May 11, page 650, and the editor's comment that the boiler might be drained of water should the safety valve on the boiler become sluggish, there is little likelihood of the valve opening at all after it has been in use a short time. Such has been my personal experience with safety valves on hot-water outlets, unless moved off their seat every day.

A safety valve will work on cold water, air and steam, but if hot water containing even a small quantity of lime or other scale-forming material is allowed to pass through it, the valve will become so attached to the seat that it may require a sharp blow to loosen it after the spring is removed. The surest way of preventing water hammer is to use two valves—one a slow-operating screw stem and the other a quick-operating one if desired—and always open the quick-acting and close the slow-acting valve first.

JAMES E. NOBLE.

Toronto, Ont., Canada.

Stopping Leak in Heater Tube

By exploring with a lighted candle over the tops of the tubes in a vertical-tube heater under slight pressure, it was found that one was leaking. The candle would be instantly extinguished when held over the leaking tube, but not when held over the others. By sliding a wad of waste into the tube on a wire it was determined that the leak was about half-way down. The heater could not be spared long enough to put in a new tube. The question was how to stop the leak. To plug the tube in the usual way the heater would have to be taken down to get at both ends.

The first attempt consisted in driving into the tube each side of the leak a wood plug long enough to reach the heater heads at both ends. This did little good.

Next, a quantity of Smooth-On cement was put on top of the plug below the leak, another plug driven in, with its top above the leak, more Smooth-On cement added, with still another plug on top extending to the upper head. Had sufficient time been allowed for the cement to harden, this plan would probably have been successful, but the tube got to leaking again after a time.

The trouble was finally stopped as follows: A plug long enough to reach to the bottom head of the heater was driven below the leak and a quantity of molten babbitt was poured in and tamped tight with an iron bar. Then an-

other plug long enough to reach from the babbitt already in to a point above the leak was driven in, and more babbitt was poured and tamped. A plug reaching to the top head was then put in, and the leak was effectually stopped.

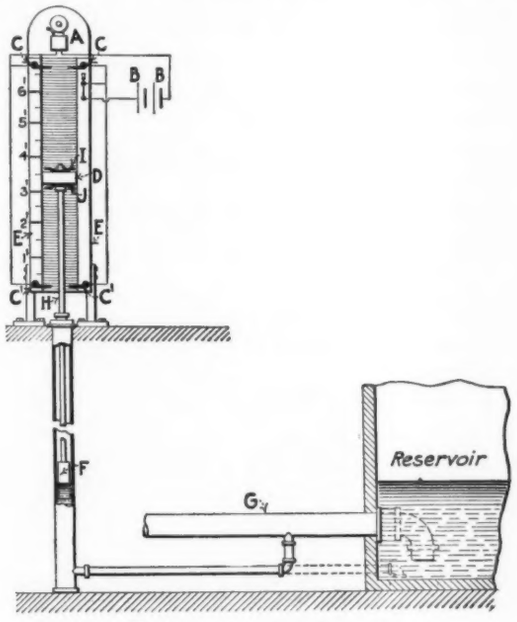
G. E. MILES.

Denver, Colo.

Reservoir Indicating Gage

Originally, the only way of telling the amount of water in our 17,500-gal. reservoir was by going out and looking down into it. In summer it was not so bad, but when the thermometer registered 40 deg. below zero it was different.

I constructed a gage to indicate the water level, which works to perfection. On a 1x6-in. board, the length of which corresponded to the depth of the reservoir, I fastened two pieces of 2-in. maple flooring *E* with their grooves facing each other. A block *D*, to slide freely in the grooves, is fastened to a light rod *H*, and on the end of this rod is a float *F*. A 3-in. pipe is used for the float to work in, and this extends down to the level of the bottom of the reservoir. A ½-in. pipe connects the 3-in. pipe to the suction pipe *G* (or to the bottom of the reservoir itself) and maintains the same water level in the 3-in. pipe as that in the reservoir. To the block *D* are fastened springs *I* and *J*, and to the top and bottom of the board



INDICATOR AND ALARM

are fastened contacts *C* and *C'*. At the top a bell is placed connected to batteries *B*. The gage is graduated in feet and inches and is so marked that the reading corresponds with the height of water in the reservoir.

When the reservoir is full the spring *I* on the block makes contact with *C* at the top, completing the circuit and ringing the bell, and at the bottom a similar contact is made when the water is low. The wiring is concealed behind the gage board, and a switch can be used to cut out the bell.

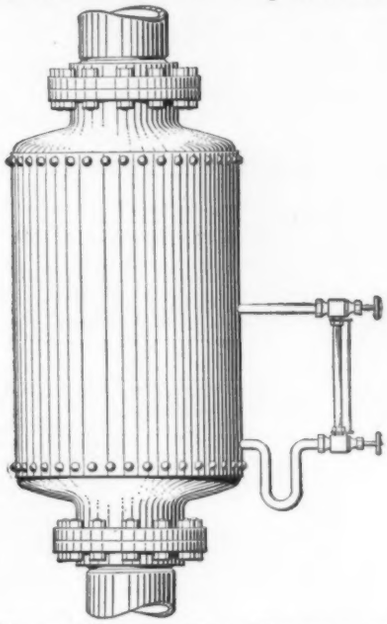
The gage is located in the most convenient place and wired so that the bell may be where the operators are most likely to hear it.

THOMAS K. LEE.

Benson, Minn.

To Prevent Gage-Glasses Breaking

Anyone troubled with separator glasses breaking should make a drop or trap in the bottom connection so as to form a water seal. This will stop the flow of steam



WATER SEAL IN GAGE CONNECTION

in the glass. The drop needs to be only from 3 to 6 in. The illustration shows the application of the idea.

FRED W. SCHNEIDER.

Clay Center, Ohio.

Steam Pressures and Piston Speed

The editorial on page 548 of the Apr. 20 issue very properly called the attention of the operating engineer to the increased hazard in engine operation today, as compared with twenty years ago, due to the increase in the steam pressures used. I had thought to criticize this editorial, because it did not take account of the fact that during the time steam pressures have been mounting higher and higher the demand for closer regulation for electric-light engines has increased, and in order to meet this demand for closer governing the weight of the flywheel has steadily increased.

The increased weight of flywheels has acted, of course, to retard the speeding up of the engine when the governor lost control, and this, in some measure, has acted to counteract the effect of the higher steam pressure tending to hasten the approach of the bursting speed in case of accident. I hesitated about sending such a criticism in, because it requires considerable temerity to take issue with an editor and I was not so sure that I was altogether right, not holding a first-class engineer's license; but since I have seen the remarks on this same editorial by Mr. Williams on page 585 of the Apr. 27 issue, I am willing to take a chance.

How a change in engine design during the last 25 years so that a working piston speed of 600 ft. per min. has been made 900 ft. per min.—or if made 9000 ft. per min.—could have such effect on the safety of flywheel operation as pointed out in Mr. Williams' article, is more than I can understand. Calling attention to the

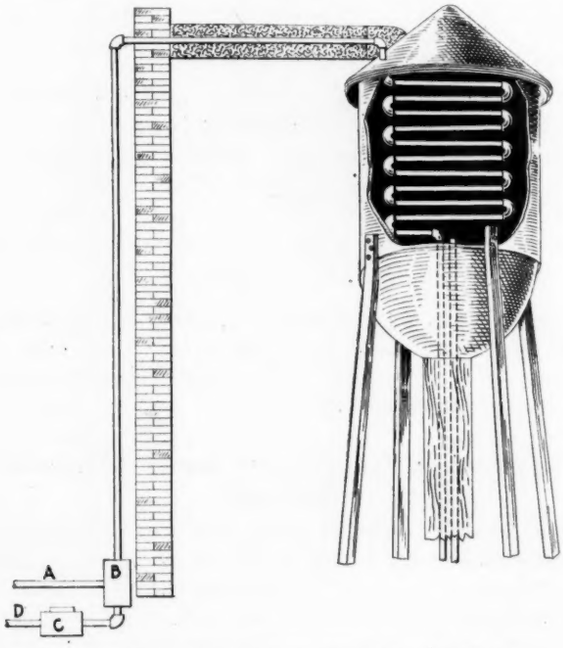
high piston speed of the modern engine as a factor contributing to flywheel accidents seems about on a par with figuring the explosive energy in a boiler from the number of pounds of coal burned per square foot of grate surface. Will not Mr. Williams enlighten us further on how high piston speed affects the safety of the flywheel?

A. K. JONES.

Melrose, Mass.

Steam Coil in Water Tank

The illustration shows a large water-supply tank. It is exposed, that is, it is erected outside and elevated 60 ft. from the ground; the water is pumped by motor or windmill from a river some distance away. The pipes to and from the tank are run underground in a waterproof



STEAM CONNECTIONS TO THE WATER TANK

box. The pipe *A* carries the exhaust from three duplex steam pumps, one of which is always working and sometimes all three are in service. A separator *B* that removes water and oil from the steam is provided, and another, *C*, which removes the oil from the condensate, so the clean water flows along pipe *D* and discharges into the hotwell; the oil is discharged into a filter. The exhaust riser runs to the tank, where it enters a coil surrounded by the tank water.

Where the pipe passes from the building to the tank it is covered for protection from frost and cold. The steam in the coil keeps the water in the tank from freezing. The water is used for domestic service as well as for the power plant, therefore the exhaust steam could not be discharged directly into it. The water in the pipes or tank has not frozen, although the outside temperature has been as low as 30 deg. F. below zero. A relief valve was attached to the exhaust pipe near the pumps to provide for any possibility of a stoppage in the coil or elsewhere.

JAMES E. NOBLE.

Toronto, Ont.

Ballade of the Stokers

The following clipping from the *Cleveland Plain Dealer,* I believe, expresses the true inward feeling of the stoker in a moment of resentment. You may care to use it.

Our muscles ache from stretch and strain,
  Our eyes are sore with salty sweat;
Our blistered skins are gnawed with pain,
  Our souls, the Devil claims for debt.
  Before us there a gage is set—
The only oriflamme we know!
  Above, they fight the foe we've met—
Who gives a damn for us below?

The great guns boom across the main,
  The Steam Boss comes with curse and threat.
We stuff the hot, red maws in vain
  Another pound of steam to get!
  With senses taut, we toil and fret
And wonder how our fortunes go.
  Above, we know they battle yet—
Who gives a damn for us below?

A crash—a roar—and cries profane!
  We slip, we sprawl—our floors are wet!
The bulkheads close, and we—remain!
  The Steam Boss lights a cigarette.
  The hot steam scalds, the waves abet—
We choke—we die—we have no show
  To save the rest! But where's regret?
Who gives a damn for us below?

Prince! And you of the epaulet!
  The world on you will praise bestow,
From Admiral to young Cadet.
  (Who gives a damn for us below?).—Planchette.

WILLIAM D. TAYLOR.

Lorain, Ohio.

Boiler Inspections

In a recent issue it is stated that boiler inspectors do not always report defects, to which statement I agree. We have state inspection here, but it seems as if the main thing is to get the inspection fee. I have been inspecting boilers for some time for various companies and have followed both the state and insurance-company inspection in various plants.

In one plant in New Mexico I was sent to inspect three horizontal-tubular boilers carrying 150 lb. pressure that had been inspected about fifteen days before. The following defects were found: A handwheel was gone on a water-gage cock; three wheels missing on the gage-glass cocks; brickwork on all the boilers in bad shape; a 6-in. globe valve had a hole in the body, over which a piece of packing was clamped to stop the leak; the pressure gages had not been tested for three years; some flues were leaking on all of the boilers at the back head, and two of the boilers had small bags on the fire sheet; in one boiler two braces were broken and they all needed scaling. I recommended that the plant be closed until repairs were made, and the superintendent nearly had a fit.

Another plant contained water-tube boilers that had been giving trouble from pitting tubes. The engineer claimed to have been an inspector and resented my making an inspection, but as I was boiler foreman I made one at the next washout. The tubes were clean owing to using a cleaner. When the manhole was removed on the steam drum, the steam line was found leaking so badly past the valve that the line had to be cut and a blind gasket put in to keep the steam out.

The drum was badly scaled, seven riser tubes were plugged and the rest were dirty. The risers were cleaned

and a new set of tubes recommended, also that all leaks in the steam line and valves be repaired before the boiler was returned to service.

It is time that the United States Government controlled the inspection of all boilers or enacted some law that will make it a criminal offense to report a boiler in good condition unless it is so.

L. B. MOORELAND.

Denver, Colo.

Charging Small Storage Batteries

In charging a small storage battery the common method is to use a bank of lamps for regulating the current, as shown in Fig. 1. By this means the current passing through the battery is roughly determined by the number and size of lamps used. The simplest way to determine the correct battery connection is to connect the wires first one way, and then the other, and note which way the lamps burn the dimmest; the dimmest is the correct way. Another simple method is to put the ends of the wires into a cup of water containing a little salt, acid or sal ammoniac; the wire around which the most bubbles are seen is the negative and should be connected to the negative side of the battery.

The foregoing method is very wasteful of electrical energy. Suppose a three-cell battery is to be charged from a 110-volt circuit; the battery will take only a little over six volts and the difference must be taken up by the lamps. Therefore, less than 7 per cent. of the energy expended is actually used in charging the battery.

To avoid this loss the writer devised the method shown in Fig. 2, where L and L' represent the wires leading

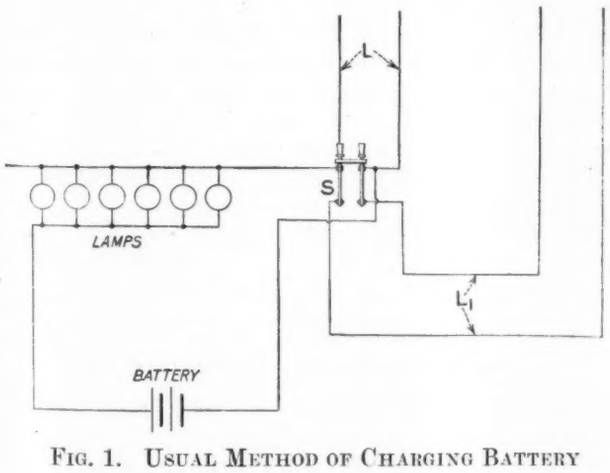


FIG. 1. USUAL METHOD OF CHARGING BATTERY

from the exciter to the main field of an alternator and S is the usual double-pole switch on the exciter circuit of the switchboard. One of these wires is disconnected from the switch S and is connected to one side (2) of a two-point switch, the common point (1) of which is connected to switch S at P. From terminal 2 on the two-point switch a wire leads to one side of the battery and the other side is connected to the remaining point (3) of the switch through an ammeter. A rheostat is connected as shown so that the current flowing through the battery can be regulated. The meter must be connected so as to measure only the current flowing through the battery.

When the two-point switch is connected from point 1 to point 2 the battery is out of circuit and should have one of its wires disconnected to prevent it from discharging through the rheostat. The battery should never be connected in circuit when the exciter is not running, for then it will either discharge through the rheostat or through the exciter, depending on which way the two-point switch is thrown.

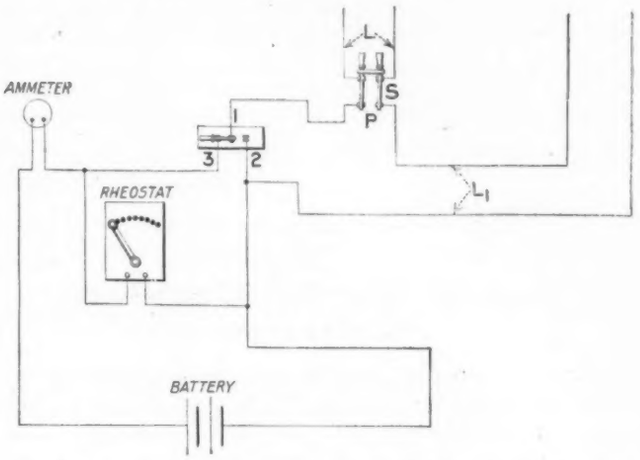


FIG. 2. CHARGING BATTERY IN SERIES WITH GENERATOR FIELD

When not charging, the two-point switch is turned to connect from 1 to 2. To put the battery in circuit, first connect the wires to it and then turn the switch to connect from 1 to 3. If the connections are right the voltage on the machine being excited will fall slightly as the voltage of the battery is deducted from that of the exciter, but if the connections are wrong the voltage of the machine will be raised slightly, as the voltage of the battery will be added to that of the exciter. This is the only test for polarity required. The battery should always be disconnected before shutting down the machine charging it, as otherwise its current will be discharged through the exciter armature and the polarity of the machine may be reversed.

When charging batteries by this method the only energy wasted is the little taken by the rheostat. This will depend on the current required for charging as compared with that passing through the exciter circuit. If the exciter circuit does not carry as much as is called for to charge the battery, the latter will have to be left in circuit longer; that is, it will have to be charged at a lower rate.

G. E. MILES.

Denver, Colo.

Electrically Controlled Damper Regulator

In Mr. Carples' comments on my letter that appeared under the above heading in POWER, Apr. 13, page 517, he says he believes it would be difficult to determine the quantity of air required to burn a certain kind and quality of coal per square foot of grate per hour. He further says I do not explain how this is determined. It is quite easy to determine, when one is getting the best

possible flue-gas analysis daily, and the coal runs uniform, as it does.

Mr. Carples is quite right in his contention that the quantity of air required changes with the quality and kind of coal and must be redetermined when these factors change. It is well known that the average CO_2 can be kept at a higher percentage under close draft regulation than when allowed a wide fluctuation, and that under close regulation the efficiency of a boiler will be high.

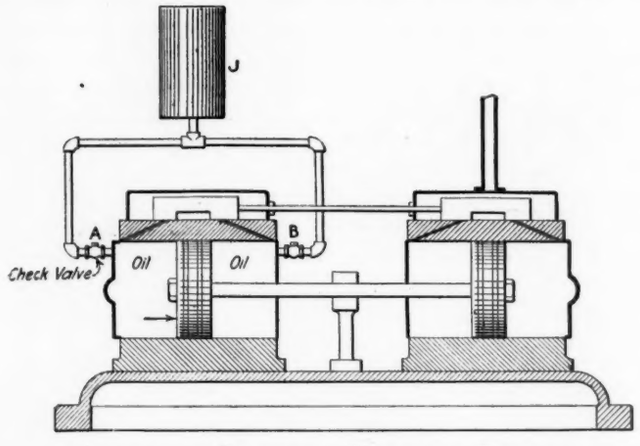
There is no balanced-draft system that I ever heard of that operates without blowers. What my letter makes clear is that we accomplish results nearly equal to those obtained by balanced-draft systems and without the use of blowers or the cost of power to operate them. I hope this is clear to Mr. Carples.

HENRY W. GEARE.

New York City.

Supply for Oil-Cushion Cylinder

On large hoisting engines and others which are reversed frequently the links are shifted by an independent steam-cylinder equipment. In order to avoid too quick and destructive motion of the piston, another cylinder filled with oil is fitted with a piston and D-valve and connected, to oppose the steam piston's motion by acting



CUSHIONING DEVICE FOR REVERSING ENGINE

on a cushion of oil. The illustration shows the general arrangement.

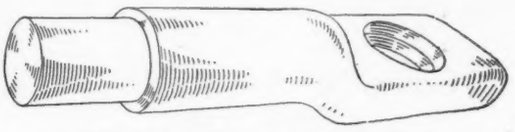
If the oil does not entirely fill the cylinder there is sure to be a jerky motion at the beginning of the stroke somewhat similar to that of a direct-acting pump which is getting air with the water it is pumping. To make sure that the cylinder was filled at all times, I connected a large oil cup *J* to the oil-cushion cylinder by means of small pipe and check valves *A* and *B*, as shown. The action is as follows: When the piston moves in the direction of the arrow, check valve *A* opens, if there is a partial vacuum created, and admits a little oil. At the same time check *B* is closed, so that there is no escape of oil through it. In the other direction the action is reversed, and the oil cylinder is kept full at all times.

G. D. DEARBORN.

New York City

Home-Made Lugs

While making some changes on a direct-current switchboard some time ago, we ran out of lugs, or terminals, and as it would take two days to get them from the nearest supply house, we decided to make them out of half-inch brass pipe annealed by heating to a dull red and ducking in water. We then sawed off several pieces



TERMINAL LUG MADE OF PIPE

about 2½ in. long and drove a piece of ⅝-in. round iron in one end about 1 in. The other end was then put in a big vise about 1¼ in. and flattened down. The iron was then removed and the hole drilled in the flat part, which was then finished up with a file. The lugs proved to be just as strong as the cast ones and, being of brass, were also good conductors. This saved us two days' delay.

J. GERBER.

Dansville, N. Y.

Paper-Mill Power Plants

I have been a reader of POWER for a long time, but do not remember reading any articles about the paper mills. I am now in charge of a plant consisting of 3300 hp. in steam and 1400 kw. generated by water power, furnishing power for making sulphite fiber and paper. Perhaps I am over-zealous in my line of business, but I should like to hear from others working along the same lines, and perhaps we might compare notes and help one another. Only one who has worked at it can know the varied experiences encountered in the pulp- and paper-mill work.

Steam is used for everything, from thawing frozen pulp to blowing out screen plates, and when things are going along fine, suddenly a 6-in. pipe line is opened into a digester, or two or three steam jets into the beaters, which will keep a man guessing how his coal report will look in the morning.

Let's make ourselves heard.

W. H. HOLMES.

Lincoln, N. H.

Examination Questions

I am sending a list of questions (from memory) which were recently asked in an examination for the position of third-class engineer, hoping they may help others.

1. What causes scale, and how is it prevented?
2. What is a water column, and is it always dependable?
3. What is a fusible plug, and what is it used for?
4. Describe a heating system, and show how condensation is returned to the boiler.
5. Name several causes for an engine pounding and the remedy for each.
6. How is an engine governed? Describe a governor.
7. Describe a feed-water heater, and give two reasons why water should be heated before entering a boiler.
8. What parts of an elevator should be inspected daily?
9. What care should be used in starting a new boiler?
10. (a) Sketch a round pipe strap. What is the vent for? (b) How is a 4-in. soil pipe calked?

RAYMOND J. CAREY.

Fitchburg, Mass.

Inquiries of General Interest

Short-Stroke of Pump—What will cause a duplex pump to reverse before completing the stroke?

C. W. O.

The pump will short-stroke if the lost motion of the steam valve is not enough to delay reversing of the steam valve until the piston has completed its stroke.

Changing from Noncondensing to Condensing—What difference should be made in the setting of the valves of a compound engine to run condensing in place of noncondensing?

M. D.

For running condensing the principal change required in the valve setting would be to secure earlier closing of the exhaust valves of the low-pressure cylinder, so as to obtain the same cushioning effect from compression of exhaust steam of lower pressure.

Flash and Burning Points of Oils—What is the difference between the flash point and the burning point of an oil?

J. R.

The flash point is the lowest temperature at which the oil discharges vapors that ignite with a flash when a lighted taper or match is passed at intervals of a few seconds over the surface of the oil, while the burning point is the temperature which the oil must attain for the vapors to burn continuously over the whole surface.

Advantage of Narrower Belt—Where the narrower belt is sufficient for transmission of the power, what saving of power would be obtained by substituting a 3-in. single leather belt in place of a 4-in. single leather belt for transmission of power from an electric motor?

P. C.

For the same total belt tension there would be no saving of power except that lost in bending the wider belt around the pulleys. With belts in good condition, the power thus lost is so small that the saving from use of the narrower belt would be inappreciable.

Why Smaller Discharge Pipe Worked Better—For pumping water over a hill a pump with a 4-in. discharge pipe would not do the work, but upon replacing the pipe with one 2½ in. diameter, a satisfactory amount of water was delivered. Why should delivery be better by use of the smaller discharge pipe?

E. A. W.

It is probable that at a time when the larger pipe was in use a greater rate of discharge was permitted from the lower end than was being supplied by the pump, and that siphonage caused the discharge line to become airbound at the crest of the hill.

Kinking of Boiler Flue—What would cause one flue of a return-tubular boiler to become warped, or kinked out of line, more than others in the same horizontal row?

F. K.

If the flue was under stresses of cold bends, such as it might have received from rough handling or from straightening the flue before it was set in the boiler, the stresses present would draw it more out of line with each repeated heating and cooling and permanent distortions would be produced to a greater extent when the cooling was sudden, as by admission of much cold air through the fire-door for the purpose of checking a hot fire.

States Having Workmen's Compensation Acts—In what states have workmen's compensation acts been passed?

S. K. C.

To this date Workmen's Compensation Acts have been adopted by 30 states, as follows: Arizona, California, Colorado, Connecticut, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Oregon, Rhode Island, Texas, Vermont, Washington, West Virginia, Wisconsin and Wyoming. In addition to these an act was passed by the State of Kentucky, but was declared unconstitutional.

Standards of Hardness of Water—What is the basis upon which the degree of hardness of water is designated?

J. B. R.

Hardness of water is usually designated according to one of the following standards of hardness:

French—Milligrams of calcium carbonate in 100 grams of water or parts per 100,000 of water.

German—Milligrams of lime in 100 grams of water, or parts per 100,000 of water.

English—Grains of calcium carbonate per Imperial gallon of 70,000 grains.

American—Grains of calcium carbonate per U. S. gallon of 58,381 grains.

Power Required for Operation of Pump—For raising water to an elevated tank, what horsepower will be required to operate a 7x10-in. pump making 95 strokes per minute with a suction lift of 8 ft. and working against a pressure of 70 lb. per sq.in., allowing for 15-per cent. slippage and 22 per cent. of the power lost in friction?

K. C.

With 15-per cent. slippage the effective length of stroke of the pump would be 85 per cent. of 10 in., or 8.5 in. A suction lift of 8 ft. would be equivalent to overcoming pressure of the atmosphere of

$$8 \times 0.434 = 3.47 \text{ lb. per sq.in.}$$

which, together with the discharge pressure, would amount to

$$3.47 + 70 = 73.47 \text{ lb. per sq.in.}$$

pressure overcome by the piston. The area of piston being

$$7 \times 7 \times 0.7854 = 38.4846 \text{ sq.in.}$$

the work performed in lifting the water would be

$$38.4846 \times 73.47 \times \frac{8.5}{12} \times 95 = 190{,}264.73 \text{ ft.-lb. per min.}$$

or at the rate of

$$190{,}264.73 \div 33{,}000 = 5.76 \text{ hp.}$$

With 22 per cent. of the applied power lost in friction, the power required for operation of the pump would be

$$\frac{5.76}{1.00 - 0.22} = 7.38 \text{ hp.}$$

Torsional Deflection of Iron Shaft—What would be the torsional deflection of a vertical iron shaft 10 in. diameter and 150 ft. long, running 200 r.p.m. and transmitting 1350 hp.?

G. H. R.

The angle of torsion is given in degrees by the formula,

$$A = \frac{583.6\ P\ a\ l}{d^4\ G}$$

in which

l = Length of shaft (inches),
d = Diameter (inches),
P = Force (pounds) applied at the extremity of a lever arm = a in inches,
Pa = Twisting moment,
G = Modulus of torsional elasticity, which for an iron shaft would be equal to about 10,000,000.

Transmitting 1350 hp. at 200 r.p.m., the foot-pounds would be

$$\frac{1350 \times 33{,}000}{200} = 222{,}750 \text{ ft.-lb. per revolution,}$$

and the twisting moment, Pa, in inch-pounds would be

$$\frac{222{,}750 \times 12}{2\pi} = 425{,}420$$

As l, the length of shaft, is 150 ft. = 1800 in., and d, the diameter, = 10 in. ,then by substitution the formula becomes,

$$A = \frac{583.6 \times 425{,}420 \times 1800}{10^4 \times 10{,}000{,}000} = 4.47 \text{ deg.}$$

which on the circumference of a 10-in. diameter shaft would measure

$$4.47 \times \frac{10 \times 3.1416}{360} = 0.39 \text{ in., or about } \frac{3}{8} + \frac{1}{64} \text{ in.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Missouri N. A. S. E. State Convention

Members of the National Association of Stationary Engineers in Missouri held their annual state convention May 19-21 at the Planters Hotel in St. Louis. With the 40 delegates and a number of visiting engineers from the vicinity, the attendance was up to normal. At the opening session, Wednesday morning, Associate City Counselor Charles H. Davies, in behalf of Mayor Kiel, welcomed the delegates to the city. In the response Fred W. Raven, national secretary, summarized briefly the aims and policies of the organization and the benefits to be derived from the practical education available to the members. Referring to Missouri's well-known motto, he suggested that the "me" be changed to "them." In other words, the members should show others the benefits to be derived from, and get them into, the organization. First of all, more interest must be taken in the work. Missouri has been drifting, and if she is to keep pace with her progressive neighbor, Kansas, there is urgent need of good work in the state. More enthusiasm, individual effort and the election of active officials were the things most needed.

J. H. Van Arsdale, past-national vice-president, reminded the engineers that they were assembled for the purpose of collectively seeing what could be done for the benefit of the organization. It stood for education, and many benefits could be derived from membership if advantage were only taken of opportunities available. Although national officers were doing all they could to improve the official paper there was need of the assistance of the engineer. The latter was not doing justice to the paper when he failed to credit its advertising pages as the source of inquiries for power-plant products. State President Daggett responded, urging a full attendance in the exhibit hall. The convention was then formally opened and the usual committees appointed.

MISSOURI N. A. S. E. DELEGATES ASSEMBLED AT ST. LOUIS

Routine business occupied the afternoon session. In the evening a get-together banquet proved a great success. Afterward, the diners retired to the exhibit hall and joined in favorite selections from the official songbook.

Much of the Thursday morning session was taken up by a discussion on the needs of the state organization. The advisability of discontinuing the convention, holding it at less frequent intervals or perhaps combining with Kansas, was considered. That general opinion favored continuance along the usual lines was evidenced on Friday when Kansas City was chosen as the convention city for 1916.

Thursday afternoon was featured by an inspection trip through the Anheuser-Busch Brewery and the manufacturing plant of the Busch-Sulzer Bros. Diesel Engine Co. In the evening an illustrated lecture by E. A. Garrett on the product of the latter company drew a large attendance.

On Friday morning news of the death of C. H. Huntington, president of St. Louis No. 2, was received with many manifestations of sorrow. The convention drew up suitable resolutions and authorized a presentation of flowers. Only necessary business was completed and all entertainment features on the program, such as a vaudeville entertainment listed for that evening, were eliminated. The following officers were elected and installed: L. Kjerluff, president; Charles Parkinson, vice-president; Rice Nance, secretary; F. H. Munsberg, treasurer; F. Middleton, conductor; Jacob Newpert, doorkeeper; Fred Key, trustee; S. J. Hunt, deputy, and L. Kjerluff, assistant deputy.

The companies represented in the unusually good exhibition and those who contributed follow:

The V. D. Anderson Co.
Arrow Boiler Compound Co.
Baumes-McDevitt Machinery Co.
Bennett-Dreyer-Buss Belting Co.
Big Muddy Coal & Iron Co.
C. J. & F. E. Briner.
Broderick-Bascom Rope Co.
Busch-Sulzer Bros.-Diesel Engine Co.
Clement-Restein Co.
Commercial Electrical Supply Co.
Crandall Packing Co.
Crane Co.
Dearborn Chemical Co.
Donk Bros. Coal & Coke Co.
The Edward Valve & Mfg. Co.
Walter L. Flower Co.
The Garlock Packing Co.
Greene, Tweed & Co.
Hawkeye Compound Co.
Heine Safety Boiler Co.
Price Hill.
Home Rubber Co.
H. W. Johns-Manville Co.
Kayser Tanning Co.
Keystone Lubricating Co.
Kupferle Bros. Mfg. Co.
A. Leschen & Sons Rope Co.
The Lunkenheimer Co.
James P. Marsh & Co.
George F. Matthews & Co.
Modern Engineering Co.
Morse Engineering Co.
Mound City Oil & Supply Co.
Mount Olive & Staunton Coal Co.
"National Engineer"
New York Belting & Packing Co.
Otis Elevator Co.
The P.-K. Engineers.
The Peerless Rubber Co.
Pierce Oil Corporation.
The William Powell Co.
"Power."
Reeves & Skinner Machinery Co.
Ridgway Dynamo & Engine Co.
St. Louis Pneumatic Tool & Supply Co.
F. C. Schwaner & Co.
Spencer Turbine Cleaner Co.
Standard Oil Co.
Western Boiler Compound & Chemical Co.
Western Valve Co.

Massachusetts Licensing Act Passed

Governor Walsh of Massachusetts signed an act on May 17 (Chapter 259) relative to the licensing of engineers and firemen, following extended discussion of this subject by the present Legislature. The act retains the supervision exercised by the boiler-inspection department of the district police over steam boilers and engines, licenses, examinations, etc. Its definitions of classes of licenses are of chief interest.

The act provides a nine-horsepower limitation on the size of boilers and engines that may be operated without a license, with the well-known exception of boilers and engines of locomotives, motor vehicles, residences and agricultural power units. Under its terms, to be eligible for examination for a first-class fireman's license, a person must have been employed as a steam engineer or fireman in charge of operating boilers for at least a year, or must have held and used a second-class fireman's license for not less than six months. To be eligible for examination for a third-class engineer's license, a person must have been employed as a steam engineer or fireman in charge of operating boilers for not less than one and one-half years, or must have held and used a first-class fireman's license for at least one year.

To be eligible for examination for a second-class engineer's license a person must have been employed as a steam engineer in charge of a plant having at least one engine of over 150 hp. for not less than two years, or he must have held and used a third-class engineer's license either as an engineer, assistant engineer or fireman for not less than one year, or have held and used a special license to operate a first-class plant for not less than two years; except that any person who has served three years as apprentice to the machinist or boiler-making trade in stationary, marine or locomotive engine or boiler works and who has been employed for one year in connection with the operation of a steam plant, or any person graduated as a mechanical engineer from a duly recognized school of technology, who has been employed for one year in connection with the operation of a steam plant, shall be eligible for examination for a second-class engineer's license. A person must have been employed for not less than three years as a steam engineer in charge of a plant having at least one engine of over 150 hp., or he must have held and used a second-class engineer's license in a second-class or first-class plant for not less than one and one-half years.

Licenses shall be distributed as follows:

Engineer's licenses: First-class, to have charge of and operate any steam plant; second-class, to have charge of and

operate boilers or engines, no one of which shall exceed 150 hp., or to operate a first-class plant under the engineer in direct charge; third-class, to have charge of and operate boilers not exceeding 150 hp. in the aggregate, or engines not exceeding 50 hp. each, or to operate a second-class plant under the engineer in direct charge; fourth-class, to have charge of and operate hoisting and portable engines and boilers; portable class, to have charge of and to operate boilers and portable engines except hoisting and steam fire engines; steam fire engineer's class, to have charge of and to operate steam fire engines and boilers.

Firemen's licenses: Extra first-class, to have charge of and operate any boiler plant; first-class, to have charge of and to operate any boiler where the safety valve is set to blow at a pressure not exceeding 25 lb. per sq.in., or to operate high-pressure boilers under the engineer or fireman in direct charge thereof; second-class, to operate any boiler under the engineer or fireman in direct charge thereof. A person holding an extra first-class or first-class fireman's license may operate a third-class plant under the engineer in direct charge of it.

Special license: A person who desires to have charge of and operate a particular steam plant may be examined for such a license, but no engine of over 150 hp. is to be operated by such a person except where the main power plant is run by water power exclusively during the major part of the time and has auxiliary steam power for use during periods of low water.

Coming Pennsylvania State N. A. S. E. Convention

The annual convention of the Pennsylvania N. A. S. E. will meet at Pittsburgh, June 18 and 19. Headquarters will be at the Monongahela House, where all sessions are to be held. State President J. D. Rostron, of Chester, Penn., will preside. The other state officers are: P. O. Johnson, Philadelphia, vice-president; R. B. Ambrose, Pittsburgh, secretary, and D. E. Seeley, Dubois, treasurer. The committee in charge of the local arrangements for the convention is made up from the membership of the three Pittsburgh associations. This committee, of which George A. Bu Miller is chairman and L. S. Evans (care Lawrence Paint Co., Pittsburgh) is secretary, is preparing an elaborate entertainment and inspection program.

New Jersey N. A. S. E. Convention

The state convention of the New Jersey National Association of Stationary Engineers will be held in Masonic Hall, Warren and State St., Trenton, June 3 to 6, inclusive. Delegates' headquarters will be at the Trenton House, opposite the exhibit hall. A large attendance is expected on account of Trenton being a central location.

J. F. Lightford, president of Trenton No. 4, N. A. S. E., is chairman of the executive committee; William Hirst, vice-chairman; William W. Law, treasurer; E. A. Corbett, secretary.

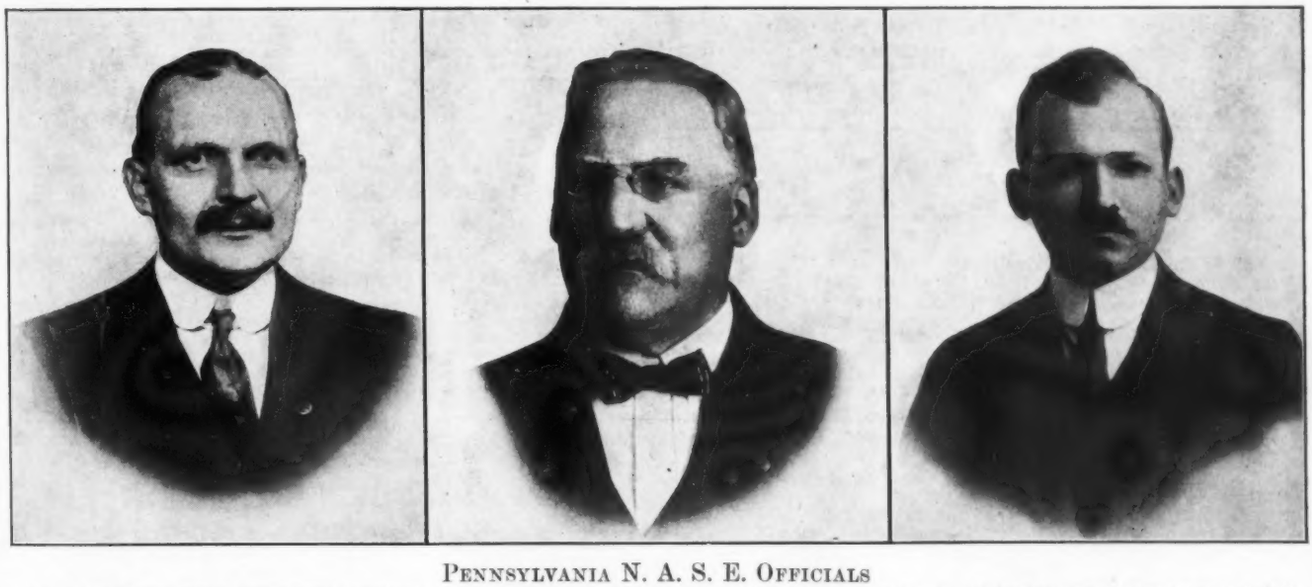
New Johns Hopkins Buildings Dedicated

After the general exercises dedicating the new engineering building and power plant of the Johns Hopkins University, at Homewood, Baltimore, Md., an inspection tour through the engineering laboratories and power station was arranged for the evening of May 21. A short talk was given by the heads of the various departments, explaining the main features of the work under their charge, closing with a few general remarks by the newly installed president, Frank Johnson Goodnow, lately constitutional advisor to the Chinese Government. Instruction in mechanical engineering is in charge of Prof. Carl Clapp Thomas, M. E.; that in civil engineering is directed by Prof. Charles Joseph Tilden, S. B., and in charge of the department of electrical engineering is Prof. John Boswell Whitehead, Ph.D.

The power-station equipment is used as far as possible for both instructive experiments and supplying heat and electric current for the buildings. The steam and electric distributing systems are in light, roomy tunnels, which also afford convenient passageways from building to building.

In the power station are four B. & W. type water-tube boilers, each having 2640 sq.ft. of heating surface and carrying 125 lb. pressure. They are equipped with automatic feed-water control, high- and low-water alarm, and in the brick setting there are openings for thermometers, draft gages, CO_2 recorders. Under two boilers there are underfeed (Taylor) stokers and under the other two overfeed (Roney) stokers. The air supply from the fan to the stokers is measured by a Thomas recording gas meter, designed by Professor Thomas, and an accurate record may be made of the air supply to check with the flue-gas analysis.

The brick chimney, 160 ft. high and 7 ft. in diameter, has openings at various points (and convenient staging or bal-



PENNSYLVANIA N. A. S. E. OFFICIALS

Jas. D. Rostron, State President (center); P. O. Johnson, State Vice-President (left); and R. B. Ambrose, State Secretary (right)

conies) from which gas samples may be obtained, and also the temperature and velocity determined.

By using Orsat flue-gas apparatus, of which there are two side by side, one a German type and the other American, the composition of the flue gas may be determined and the degree of efficiency of the furnace operation indicated. A Pintsch CO_2 recorder, which is a new and interesting development, takes samples of gas from the breeching just below the damper. It passes through a dry excelsior purifier, then enters a cooling coil that is jacketed by the water used to operate the ejector. This brings the gas to a constant temperature. It next passes through a small precision gas meter containing light mineral oil and then through an absorber, where the CO_2 is removed. The absorbing agent is slaked lime mixed with sawdust to keep it porous. This can be readily renewed once a week at very small cost. After leaving the absorber the gas passes through another cooling coil to remove the heat generated by the absorption of the CO_2 and is then directed through a second precision gas meter. The siphon ejector is placed after the second meter. The first meter measures all the gas; the second measures a lesser quantity by the amount of CO_2 absorbed, and therefore runs

slower. A differential gear and mechanism transmutes this speed difference into vertical pen motion and makes a record on the chart. The pen is released and makes a dot on the chart for every cubic foot passing, its relative position indicating the percentage of CO_2. The coal- and ash-handling systems are so arranged that during tests accurate weights may be taken.

From the boilers the steam may be led through an independently fired superheater to the engines or by a direct line in a saturated state, so as to demonstrate the effect of superheat on the efficiency and steam consumption in the engines under various conditions of operation.

In the main engine room there are three units: A Harrisburg four-valve reciprocating engine rated at 150 hp. at 200 r.p.m., directly connected to a Westinghouse 100-kw., 250-volt generator. A Kerr (Economy) turbine, connected to an Allis-Chalmers 100-kw. generator; and a Westinghouse turbine set. All of these are so piped that the exhaust steam may be used for heating the buildings or may be directed to a Wheeler surface condenser having 300 sq.ft. of cooling surface capable of condensing 2500 lb. of steam per hour with cooling water at 70 deg. The condensation may be led to the weir tanks and measured. The cooling water also is measured by a venturi meter.

In another part of the building a Nash producer-gas engine rated at 14 hp. is supplied by a Smith suction gas producer using anthracite coal, which gives the student an idea of the general requirements of such apparatus.

A Diesel-type crude-oil engine loaned by the Allis-Chalmers Manufacturing Co. is used for experimental purposes. It is equipped with special attachments for testing and is capable of using almost any kind of clean liquid fuel.

On the floor above, a Buckeyemobile engine, directly connected to a 75-kw. generator, represents the latest development in a self-contained steam unit of remarkable efficiency. Various other equipment connected with the heating and ventilating operation, and meters, oil testers, calorimeters, etc., give the student a comprehensive insight into actual power-plant management and, together with extensive laboratory equipment, make it possible for the instructor to demonstrate the latest practice in engineering.

PERSONALS

Walter R. Johnson is no longer associated with the Harrison (Cochrane) Safety Boiler Works. He was formerly Southern representative, with headquarters at Atlanta, Ga.

H. D. McCaskey has been designated as statistician in charge of the Division of Mineral Resources, U. S. Geological Survey, succeeding Edward W. Parker, resigned, as noted elsewhere. Mr. McCaskey was a mining engineer in the Philippine Mining Bureau from 1900 to 1906, and has been with the Geological Survey since 1907. He will also continue his work upon the metallic resources of the United States.

Edward W. Parker, statistician in charge of the Division of Mineral Resources, U. S. Geological Survey, and for many years the Government coal statistician, leaves the Government service July 1 to accept a responsible position with the anthracite mining interests. Director George Otis Smith, of the Survey, has gone on record as expressing his regret at this termination of Mr. Parker's long and efficient service, which, in addition to the work mentioned, has comprised a study of coal testing and conservation and the publication in the engineering press of many papers on coal mining and production.

ENGINEERING AFFAIRS

The Worcester Polytechnic Institute will celebrate its fiftieth anniversary June 6-10. The dedication of a new gymnasium, a special meeting of the American Society of Mechanical Engineers to be held at the works of the Norton Co., and the annual commencement exercises are among the events scheduled. President Wilson, who was the commencement orator twenty-five years ago, has expressed a desire to be present, and it is hoped that the pressure of public business may permit his attendance. Gen. George W. Goethals has already accepted an invitation to be present.

NEW EQUIPMENT

ATLANTIC COAST STATES

Bids will be received until June 1 by the Children's Institution Department, Boston, Mass., for a 15-kw. direct-connected engine and generator at Rainsford Island. John O'Hare is Comr.

The town of Milford, Mass., is considering the purchase of the plant of the Milford Electric Light & Power Co. William Plattner, Attleboro, has been retained to appraise the value.

At a recent town meeting in Sterling, Mass., an appropriation of $5900 was made for extending the transmission lines of the municipal electric-lighting system as follows: Camp grounds at Sterling Junction, $2600; Rowley Hill district, $2000, and to the Chocksett district, $1300. H. W. Rugg is Mgr. and Supt. of the municipal plant.

Bids will be received until June 1 by C. B. J. Snyder, Supt. of School Buildings, Park Ave. and 59th St., New York, N. Y., for additions, alterations and repairs to the electrical equipment in Public Schools 25, 31, 44, 62, 177 and 188, Borough of Manhattan.

It is reported that the Crucible Steel Co. of America, Harrison, N. J., will build a new power station on Cumberland St. in connection with the extensions to its plant.

The Atlas Finishing Co., Homestead, N. J. (West Hoboken post office), plans to build a one-story power house.

The Toms River & Island Heights Electric Light & Power Co., Toms River, N. J., will soon install one 125-hp. Coatesville boiler in its plant. C. A. Brant is Secy. and Mgr.

The Borough Council of St. Clair, Penn., is considering plans for improving the municipal electric-light plant. J. J. Hughes is Mgr. of the plant.

The City Council of Cumberland, Md., is reported to be considering improvements to the municipal electric-lighting system at an estimated cost of $15,000. A high-speed steam turbine, directly connected, will be installed, and the present street-lamps will be replaced by new ones. James P. Gaffney is City Engr.

SOUTHERN STATES

According to press reports, the North Carolina Electrical Power Co., Asheville, N. C., plans to build a steam-driven auxiliary electric plant on the French Broad River to cost about $150,000. Generating equipment for 4000 hp. will be installed this year. W. T. Weaver, Asheville, is Pres. and Mgr.

At a recent election the citizens of Waynesville, N. C., voted in favor of issuing $25,000 in bonds to be used for the installation of a municipal electric-light plant.

Bonds in the sum of $10,000 have been voted by the citizens of Gleason, Tenn., for the construction of a municipal electric-light plant.

The Lancaster Electric Light Plant, Lancaster, Ky., will increase the equipment of its plant to provide 24-hr. service for the town. Alex Walker is interested.

CENTRAL STATES

Press reports state that the City Council of Oberlin, Ohio, is considering the installation of a municipal electric-light plant and water-works system.

It is reported that the new Alhambra Theater, Sandusky, Ohio, will be equipped with an independent electric-light and power plant. The equipment will include a 90-hp. Bruce-McBeth engine and a 50-kw. generator, directly connected.

It is reported that the Western Drop Forge Co., Marion, Ind., will increase its power plant by the addition of 700 hp.

WEST OF THE MISSISSIPPI

Bids will be received until June 7 by the Town of Alta Vista, Iowa, for the construction of an electric transmission line and a distribution system for the town. F. Rabe is Town Clk.

The town of Charter Oak, Iowa, has sold bonds, the proceeds of which will be used for the installation of a municipal electric-light plant.

A special election will be held in Lake City, Iowa, to vote on the question of granting a 25-year franchise to the Central Iowa Light & Power Co., Boone, to furnish electricity for lamps and motors in Lake City.

The City Council of Wilton Junction, Iowa, has rejected the offer made by the Davenport & Muscatine Ry. Co., Davenport, to build a transmission line to Wilton Junction, and will rebuild the municipal electric plant. George Bannock is Mayor.

Preliminary plans are being prepared for the installation of a municipal electric-lighting system for the town of Muscotah, Kan.

It is reported that the Texas Southern Electric Co., Victoria, Tex., has purchased the electric-light and ice factory of the City Ice & Electric Co., Del Rio, Tex. The reported purchase price is $90,000. The new owners will improve the property.

Bids will be received until June 3 by Wilson & Cutting, Engrs., 325 Electric Bldg., Butte, Mont., for the installation of an electric-heating system (indirect with fan) in the High School at Burley, Idaho. The building contains 40 rooms.

The plant of the Morton Electric Co., Morton, Wash., owned by F. M. Broadbent, has been sold to C. O. Smith of Pe Ell, Wash., at approximately $20,000. The plant will be enlarged and improved at once.

It is reported that the West Virginia Mining Co., operating the Lone Surprise mine at Republic, Wash., will install a 200-hp. compressor, a new Diesel engine and an electric hoist.